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Mr. James A. Saric, Remedial Project Manager
U.S. Environmental Protection Agency
Region V-SRF-5J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

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Dear Mr. Saric and Mr. Schneider:

TRANSMITTAL OF THE FINAL ON-SITE DISPOSAL FACILITY GROUNDWATER/LEAK DETECTION AND LEACHATE MONITORING PLAN

References: (1) Letter and enclosures from J. Reising, U.S. DOE to J. Saric, U.S. EPA and T. Schneider, OEPA, "Responses to U.S. EPA and OEPA comments on the Draft Final IEMP and Responses to OEPA Comments on the Draft Final OSDF Groundwater/Leak Detection and Leachate Monitoring Plan," dated May 23, 1997.

(2) Letter from T. Schneider, OEPA to J. Reising, U.S. DOE, "Approval - OSDF Groundwater/Leak Detection and Leachate Monitoring Plan," dated July 28, 1997.

This letter serves to transmit the subject document. The document has been revised to its final form by incorporating actions associated with the comment responses in Reference 1. These comment responses were approved by the Ohio Environmental Protection Agency (OEPA) in Reference 2. The On-Site Disposal Facility (OSDF) Groundwater/Leak Detection Monitoring Plan had previously been approved by the U.S. Environmental Protection Agency (U.S. EPA) without comment.

The Department of Energy (DOE) initiated minor revisions to Section 5.1 (Monitoring to Support Leachate Treatment and Discharge). These revisions were made to more accurately reflect treatment plans and to clarify that the National Pollutant Discharge Elimination System (NPDES) permit application currently being prepared includes consideration of OSDF leachate as a waste stream.

If you have any questions regarding this submittal, please contact Kathleen Nickel at (513) 648-3166.

Sincerely,

Johnny Reising

FEMP:Nickel

Johnny W. Reising
Fernald Remedial Action
Project Manager

Enclosure: As Stated

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GROUNDWATER/LEAK DETECTION AND LEACHATE MONITORING PLAN

ON-SITE DISPOSAL FACILITY

AUGUST 1997

United States Department of Energy
Fernald Area Office

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Revision 0
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GROUNDWATER/LEAK DETECTION AND LEACHATE MONITORING PLAN

ON-SITE DISPOSAL FACILITY

AUGUST 1997

United States Department of Energy
Fernald Area Office

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LIST OF ACRONYMS

ADM	analytical data management
ARARs	applicable or relevant and appropriate requirements
ASL	Analytical Support Level
AWWT	advanced wastewater treatment facility
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	constituent of concern
COC/RFA	Chain of Custody/Request for Analysis
CPTs	cone penetrometer tests
D&D	decontamination and demolition
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FAL	Field Activity Log
FD	Fluor Daniel
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FRL	final remediation level
HDPE	high density polyethylene
IEMP	Integrated Environmental Monitoring Plan
LCS	leachate transmission system
LDS	leak detection system
LTS	leachate transmission system
MS/MSD	matrix spike/matrix spike duplicate
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
SCQ	Sitewide CERCLA Quality Assurance Project
SDWA	Safe Drinking Water Act
SED	Sitewide Environmental Database
SOP	Standard Operating Procedure
SWIFT	Sandia Waste Isolation Flow and Transport
TBC	to be considered criteria
TDS	total dissolved solids
TOC	total organic carbon
TOX	total organic halogens
UMTRCA	Uranium Mill Tailings Radiation Control Act
WAC	Waste Acceptance Criteria

1.0 INTRODUCTION

This document presents the groundwater/leak detection and leachate management monitoring program for the On-Site Disposal Facility (OSDF) at the U. S. Department of Energy's (DOE's) Fernald Environmental Management Project (FEMP). This plan is a support plan for the OSDF that is required by the Remedial Action (RA) Work Plan for the OSDF (DOE 1996e). Following its approval by the U. S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA), this plan will be used to monitor the performance of the OSDF.

As will be discussed in detail in this document, the monitoring program is divided into two primary elements: (1) a leak detection component, which will provide information to verify the ongoing performance and integrity of the OSDF and its impact on groundwater; and (2) a leachate monitoring component, which will satisfy regulatory requirements for leachate collection and management. The leak-detection monitoring layers (a leak detection layer inside the facility, and two groundwater zones occurring in the subsurface below the facility) will be utilized collectively to assess the existence of leakage from the facility and to satisfy OSDF groundwater monitoring requirements. The two groundwater zones in the monitoring plan are the Great Miami Aquifer (found at depths ranging from 45 to 90 feet beneath the facility) and the perched groundwater residing in the glacial till overlying the Great Miami Aquifer.

This OSDF monitoring plan has been developed to meet the regulatory requirements for groundwater detection monitoring in both the Great Miami Aquifer and the perched groundwater system. These detection monitoring requirements constitute the first tier of a three-tiered detection, assessment, and corrective action monitoring strategy required for engineered disposal facilities. Consistent with this three-tiered requirement, if, in the future, it is determined from detection monitoring that a leachate leak from the OSDF into the underlying natural hydrogeologic environment has occurred, follow-up groundwater quality assessment and corrective action monitoring plans will be developed and implemented as necessary. Conversely, if the detection monitoring continues to successfully demonstrate that leachate leaks are not of concern (i.e., the facility is performing as designed), then the monitoring program will remain in the first-tier "detection mode" and the need for the follow-up groundwater quality assessment and/or corrective action monitoring plans will not be triggered.

1.1 Overview of the On-Site Disposal Facility

The OSDF will ultimately provide on-site disposal capacity for an estimated 2.5 million cubic yards of contaminated soil and debris generated through the FEMP's environmental restoration and building decontamination and demolition (D&D) activities. The OSDF footprint (including the capped area extending beyond the disposal area) is anticipated to occupy approximately 70 acres of the 1050-acre FEMP property. This area will be dedicated to disposal and will remain under federal administrative control following the completion of the FEMP's cleanup mission. The OSDF will be sited along the northeast portion of the FEMP property and, as required by the FEMP's Operable Unit 2, 3, and 5 Records of Decision, is situated over the "best available geology" at the FEMP to take maximum advantage of the protective hydrogeologic features of the glacial till above the Great Miami Aquifer.

The OSDF will be constructed in phases, with eight individual cells planned, plus a ninth contingency cell, if needed. Each individual cell is planned to be 700 feet by 400 feet, or 280,000 square feet (6.5 acres). Each individual cell will be constructed with a leachate collection system (LCS) to collect infiltrating rainwater (and storm water runoff during waste placement) and prevent it from entering the underlying environment. Other engineered features include a multi-layer composite liner system; a leak detection system (LDS) positioned beneath the primary liner; and a multi-layer composite cover that will be placed over each cell following the completion of waste placement activities. The LCS and LDS layers will each drain to the west to a point where the collected fluids will be removed from each layer for treatment (these LCS and LDS collection points are referred to as "sumps" for the remainder of this plan). The "sumps" represent the lowest elevational area of each cell and the location of the extraction piping needed to remove the collected fluids for subsequent treatment. By definition, these necessary features cause the "sumps" within each cell to be the most likely location for a potential leak to originate.

1.2 Program Overview

The OSDF monitoring plan was developed by reviewing the pertinent regulatory requirements for detection monitoring and translating those requirements into site-specific monitoring elements (designation of monitoring zones, monitoring station locations, sampling frequency, and establishment of analytical parameters). As the remaining sections of this plan will discuss, the OSDF monitoring strategy is responsive to monitoring needs both during the active remediation of the site and during the post-remediation period when restoration activities at the FEMP are complete. Similarly, the strategy recognizes the various operating phases of the OSDF including the periods before, during, and after waste placement, at which point the facility will enter a long-term post-closure care mode after the final cap is in place.

The plan also considers current hydrogeologic and contaminant conditions in the glacial till and Great Miami Aquifer beneath the facility. Pre-existing contamination in the perched groundwater system and the Great Miami Aquifer, the variable nature of the geology and hydrogeology of the clay-rich glacial deposits, and the influence of aquifer restoration activities in the Great Miami Aquifer

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add complexity to the development of a groundwater monitoring program. The Great Miami Aquifer will be undergoing restoration during the same overall time period that the OSDF will be actively accepting waste for disposal. During the aquifer restoration activity, current flow conditions in the aquifer will be modified as new area-specific restoration modules are brought on line and other restoration modules are retired from service following attainment of restoration objectives within a particular area. Once aquifer restoration activities are complete, natural flow conditions in the aquifer, including those in the vicinity of the OSDF, are expected to be restored.

The development of the monitoring strategy and monitoring locations for the OSDF considered all of the available site-specific information that has been generated from more than ten years of detailed site characterization efforts at the site, including current representations of the site geology and hydrogeology, results of detailed contaminant fate and transport modeling, and the anticipated impacts of OSDF construction and groundwater remediation activities on the scope of the plan.

The overall strategy employs a four-layer vertical slice/trend analysis approach to independently monitor the potential for leachate generation and leakage from each of the individual disposal cells comprising the facility. As part of this strategy, "baseline" conditions for each individual cell will be established to facilitate trend analysis for data generated for each of the monitoring stations over time. The initial baseline condition for each cell will be established prior to actual waste placement in the individual cell (i.e., over a time period that extends up through construction of the cell's composite liner system and other elements necessary to prepare for waste placement). This initial baseline will help define existing conditions in both the perched groundwater and the Great Miami Aquifer in the immediate vicinity of the facility.

This plan focuses primarily on the monitoring needs associated with active cell operations and the definition of the baseline. Future amendments to the plan will be prepared to address program modifications as necessary for each cell once waste placement is complete and the cell has been capped. At that point in time, the cell will enter its inactive (post-closure care) mode. An in-depth review of program needs is also envisioned at the completion of Great Miami Aquifer restoration activities and the return of natural flow directions and rates in the aquifer. At that point, formal long-term upgradient to downgradient comparisons of analytical data gathered for the Great Miami Aquifer can effectively begin, a key regulatory requirement for detection monitoring. Prior to the closure of the cells and the completion of the aquifer restoration activities, the data comparisons will focus on shorter-term "interim" leakage effects that might potentially occur during active cell operations. The initial baseline established at the beginning of cell operations will enhance the ability to conduct the interim comparisons until the facility enters its final long-term post-closure mode and aquifer restoration activities are complete.

Throughout this process, the analytical results and trend analyses for all three leak-detection monitoring layers (the LDS, perched groundwater, and the Great Miami Aquifer) and the LCS will be compared with one another to evaluate the overall performance of each cell and to determine whether a release from the facility has occurred. In concert with the groundwater monitoring component of the program, the leachate characterization and tracking component will provide for the monitoring of leachate concentrations and flows in the LCS and LDS to support leachate management and treatment decisions.

As part of this effort, contaminant concentrations in the leachate (if present) collected from the LCS and LDS will be compared to one another and to the groundwater concentrations in the perched groundwater and Great Miami Aquifer monitoring systems. Additionally, trend analysis of the LCS and LDS flow monitoring measurements will be conducted in order to provide indication of changes in trends in containment system performance far enough in advance to allow application of appropriate follow-up inspection and corrective action measures as necessary.

During the development of this plan, EPA and OEPA identified the need to monitor the potential for leachate leakage from the OSDF at its first point of entry into the natural hydrogeologic environment (rather than relying on Great Miami Aquifer groundwater monitoring alone). This led to the decision to install horizontal monitoring wells in the glacial till directly beneath the "sumps" of the LCS and LDS layers in each cell. The subsurface area beneath the "sumps" is considered to provide the best opportunity to monitor for an initial leak into the subsurface environment, should such a leak occur. As a result of the low transmissive properties of the glacial till and the discontinuous nature of the perched groundwater system in the till, it may not be possible to collect fluids routinely from the horizontal wells. In view of this limitation, DOE, EPA, and OEPA concur that the placement of the horizontal wells beneath the sumps represents the most feasible site-specific approach to monitor for first-entry leakage from the facility to the FEMP environment, and this approach will provide adequate and appropriate early-warning detection capabilities for this site-specific setting.

Once approved, the groundwater monitoring plan will be implemented as a project-specific plan for the OSDF, with the results presented for EPA and OEPA review as part of the FEMP's comprehensive Integrated Environmental Monitoring Plan (IEMP). The IEMP will provide a consolidated reporting mechanism for all of the FEMP's individual environmental regulatory compliance monitoring activities including the data and findings for this OSDF groundwater monitoring plan. Incorporating the OSDF data into the IEMP will maintain the FEMP's continued commitment to an effective remediation-focused environmental surveillance monitoring program. Once the FEMP has completed its environmental remediation requirements and the site is successfully removed from the Superfund National Priorities List (NPL), the monitoring activity for the OSDF (which will be the last

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remaining facility in place at the site) will continue in accordance with applicable regulatory monitoring and reporting requirements.

1.3 Plan Organization

The remainder of this plan is organized as follows:

- A summary of the geology and hydrogeology in the immediate area of the OSDF is provided in Section 2.0;
- A regulatory analysis and strategy for OSDF monitoring is provided in Section 3.0;
- The OSDF leak detection monitoring program is provided in Section 4.0, including a description of program elements, monitoring frequencies, selection of analytical parameters, and data evaluation; and
- The OSDF leachate management monitoring program, which will be used to support leachate management decisions, is provided in Section 5.0;
- Reporting requirements and notifications are provided in Section 6.0; and
- References are provided in Section 7.0.

The four appendices that support the plan are:

- Appendix A - OSDF ARARs and Other Regulatory Requirements
- Appendix B - Sampling and Analysis Requirements
- Appendix C - Quality Assurance/Quality Control
- Appendix D - Data Management Plan

1.4 Related Plans

Several other remedial action plans being prepared for the OSDF, or for the FEMP site as a whole, contain information relevant to this plan. These other plans are listed below along with a brief statement of their relationship to this plan:

- *OSDF Systems Plan* (GeoSyntec, 1996b): describes the inspection and maintenance for the LCS and LDS prior to closure of the OSDF.
- *OSDF Post-Closure Care and Inspection Plan* (FERMCO, 1996): describes the post-closure care and inspection for the LCS and LDS, and summarizes at the conceptual level corrective actions/response actions.

- *IEMP* (DOE, 1997): describes FEMP sitewide environmental monitoring efforts and the requirements for reporting on environmental monitoring, including the data collected from this OSDF monitoring program.

2.0 OSDF AREA GEOLOGY AND HYDROGEOLOGY

2.1 Introduction

The Operable Units 2, 3, and 5 Records of Decision contain requirements that the OSDF be located in an on-site area of the FEMP that takes maximum advantage of available geologic and hydrogeologic conditions to further reduce the potential for contaminant migration from the facility. To identify the preferred OSDF location, a detailed predesign geotechnical and hydrogeologic investigation was conducted as a supplement to the sitewide characterization efforts contained in the Operable Unit 5 Remedial Investigation (RI) Report (DOE, 1995d). The detailed findings of the predesign investigation are documented in the Predesign Investigation and Site Selection Report for the OSDF (DOE, 1995c). As documented in the site selection report, a final site location along the eastern margin of the FEMP was selected to satisfy the Records of Decision and other regulatory-based siting requirements.

The following sections summarize the principal geologic, hydrogeologic, and subsurface contaminant conditions in the OSDF site area that have a direct bearing on the development of the leak detection and groundwater monitoring strategy for the facility. For more detailed information, the reader is referred to the Predesign Investigation and Site Selection Report and the Operable Unit 5 RI Report.

2.2 OSDF Area Geology

The OSDF, inclusive of its final cap configuration, is expected to occupy an area of approximately 70 acres along the eastern margin of the FEMP. The facility will be oriented in a north to south direction with ultimate dimensions at closure expected to be 3900 feet by 1000 feet. The facility will be set back from the eastern property line by approximately 300 feet. The subsurface conditions in the immediate area of the selected OSDF location have been characterized through the following field and laboratory activities:

Test Borings	Fifty-four (54) borings were drilled in the immediate vicinity of the OSDF to obtain geotechnical soil samples and characterize underlying geology
Monitoring Wells	Fifty-one (51) groundwater monitoring wells were installed in the general vicinity of the OSDF from which water level, pre-existing groundwater contaminant concentration data, and lithology data have been obtained

Geotechnical Tests	Key geotechnical tests (i.e., Atterberg limits, water content measurements, and permeability tests) were performed on subsurface geologic samples including 116 grain-size sieve analyses.
Lysimeter Installation	Eight (8) lysimeters were installed in the OSDF site area to determine the nature and concentration of uranium in the vadose zone of the glacial till and the unsaturated Great Miami Aquifer.
Slug Tests	Twenty-four (24) slug tests were performed to assess the hydraulic characteristics of the perched groundwater system.
Water Level Monitoring	Water levels obtained from the perched groundwater and the Great Miami Aquifer wells were used to determine hydraulic gradients and flow directions
Soil Analyses	Soil samples collected during the RI and the Predesign Investigation were analyzed for uranium and other constituents of concern to determine pre-existing contaminant levels in the subsurface beneath the OSDF
Groundwater Flowmeter Study	Twenty-two (22) flowmeter readings were obtained in the perched groundwater in the OSDF site area.
K_d Study	A distribution coefficient (K_d) study was performed to determine how uranium will partition itself between groundwater and soil in the OSDF site area.
Cone Penetrometer Tests (CPTs)	Eighty-eight (88) CPTs were conducted in the OSDF site area to aid in making subsurface lithologic interpretations.

The information obtained through these activities, coupled with the sitewide interpretations gained through the Operable Unit 5 RI, form the basis for the current interpretations of subsurface conditions in the vicinity of the OSDF site.

In general, the OSDF site is situated on glacial till underlain by sand and gravel deposits which comprise the Great Miami Aquifer, designated as a sole source aquifer under the Safe Drinking Water Act (SDWA). The Great Miami Aquifer is a high-yield aquifer (wells completed in some areas of the aquifer yield greater than 500 gallons of water per minute) and supplies a significant amount of potable and industrial water to people located in Butler and Hamilton counties.

The glacial till ranges in thickness from approximately 20 to 60 feet in the immediate vicinity of the OSDF. Based on the results of 116 sieve and hydrometer analyses, the till can be characterized as a dense, heterogeneous sandy lean clay, with occasional discontinuous interbedded sand and gravel lenses. The glacial till can be further divided into an upper brown clay layer and a lower gray clay layer. The brown clay layer is more weathered and contains a greater abundance of desiccation fractures compared to the underlying gray clay layer, and a higher incidence of interbedded sand and gravel lenses. In the eastern portions of the FEMP, the gray clay ranges in thickness from approximately 15 to 42 feet, and the brown clay ranges from approximately 8 to 15 feet. As indicated sitewide by the Operable Unit 5 RI, the gray clay is the most uniform and least permeable (and therefore most protective) geologic layer found above the Great Miami Aquifer.

As a follow-up to the Operable Unit 5 RI, one of the primary objectives of the Predesign Investigation was to identify the location where the thickest laterally persistent gray clay layer is present that contains the least amount of interbedded coarse granular material and which allows regulatory-based siting requirements (such as property-line and other geographic setbacks) to be met. The selected location for the OSDF has a minimum thickness of gray till of approximately 15 feet and an average thickness of approximately 30 feet. The percentage of interbedded sands and gravels in the gray till in this area is approximately four percent.

Beneath the glacial till layer, the sand and gravel deposits comprising the Great Miami Aquifer are approximately 175 feet thick. For RI characterization and monitoring purposes, the Great Miami Aquifer deposits have been divided into three geologic zones: the uppermost zone, represented by the FEMP's Type 2 monitoring wells; the middle zone, represented by the Type 3 monitoring wells; and the lowermost zone, represented by the Type 4 monitoring wells. The sand and gravel deposits comprising the aquifer are really extensive and, at the regional scale, occupy a land area of more than 970,000 acres.

Beneath the Great Miami Aquifer deposits, shale and limestone bedrock is encountered at a total depth of approximately 200 feet beneath the planned OSDF site. Regional studies by the Geological Survey of Ohio indicate the shale and limestone bedrock is approximately 330 feet thick in the FEMP area (Fenneman, 1916).

2.3 Hydrogeologic Conditions

The FEMP has two distinctive bodies of groundwater that have been extensively characterized through the remedial investigation/feasibility study (RI/FS) process and the Predesign Investigation: the Great Miami Aquifer, and the perched groundwater found within the overlying glacial till. The discontinuous sand and sand/gravel lenses found within the glacial till can provide water to a pumping well because the deposits are more permeable than the surrounding less permeable clay-rich glacial till.

The entire section of glacial till is believed to be saturated or near-saturated with groundwater. An unsaturated sand and gravel zone approximately 20 to 30 feet thick separates the base of the glacial till from the regional water table in the Great Miami Aquifer. Depending on localized weather patterns and rainfall, the water table in the Great Miami Aquifer fluctuates up to eight feet yearly within the unsaturated zone separating the two groundwater systems.

The Great Miami Aquifer is a classic example of an unconfined buried valley aquifer. The depth to water in the aquifer in the vicinity of the OSDF ranges from 45 to 90 feet below the ground surface. The groundwater flow direction in the aquifer in this area under natural conditions is from west to east, with an average hydraulic gradient of approximately 6.25×10^{-4} ft/ft. Based on pump test data and other hydraulic information collected during the RI/FS process, the average hydraulic conductivity of the aquifer is approximately 1.6×10^{-1} cm/sec, the average effective porosity is approximately 30 percent, and the bulk density averages 1.8 g/cm^3. Using the representative distribution coefficient (K_d) for uranium of 1.78 L/kg determined through the RI/FS process, the retardation factor for uranium movement in the Great Miami Aquifer is 12. Using the above parameters, the average groundwater flow velocities in the Great Miami Aquifer are approximately 345 ft/year, and thus uranium in the aquifer would be expected to migrate at an average rate of approximately 30 ft/year.

Perched groundwater is present above the unsaturated zone of the Great Miami Aquifer within the glacial till. Overall the till exhibits between 90 to 100 percent saturation (close to field capacity) and has the general properties of an aquitard. When the till reaches field capacity it has the capability to release groundwater downward under a unit vertical hydraulic gradient into the underlying unsaturated zone of the Great Miami Aquifer. Eventually, this downward moving groundwater will enter the saturated portion of the Great Miami Aquifer as recharge. Depths to perched groundwater in the till are generally 6 feet or less in the eastern portion of the FEMP in the area of the OSDF.

Although the till is generally saturated, there are no identified suitably thick or laterally continuous coarse-grained zones beneath the OSDF that can facilitate implementation of a comprehensive, interlinked (i.e., up and downgradient monitoring points) perched groundwater monitoring system. The present amount of saturation in the till is expected to be reduced even further in the future, once the cap and underlying liners of the OSDF are in place which will serve as local hydraulic barriers to further reduce the quantity of infiltrating moisture within the OSDF footprint.

Slug test data from 24 perched groundwater wells (the Type 1 monitoring wells) indicate that the average horizontal hydraulic conductivity for wells screened across the brown and gray clay layer interface is 6.30×10^{-6} cm/sec. The gray clay layer beneath the brown clay is the least permeable layer above the Great Miami Aquifer. Laboratory hydraulic conductivities conducted on samples collected

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from this layer indicate measured values ranging from 9.53×10^{-9} cm/sec to 5.83×10^{-8} cm/sec. Other laboratory and field measurements indicate the till has an effective porosity of four to ten percent, and a representative bulk density of 1.85 g/cm^3. The discontinuous nature of the perched water in the glacial till does not facilitate the measurement of a continuous water table gradient in the OSDF site area.

Model calibration studies conducted during the Operable Unit 5 RI/FS indicate average vertical groundwater flow rates through the glacial till (including the gray clay layer) to be approximately six inches per year. The time it takes a contaminant to move through the glacial till and break through into the Great Miami Aquifer is controlled by the thickness of gray clay present in the till, the groundwater infiltration rate through the gray clay, and the retardation properties of the gray clay. In the OSDF site area, modeled breakthrough travel times for uranium, the FEMP's predominant contaminant, range from approximately 210 years (to have a 20 μg/L concentration in the aquifer) to 260 years (to have one percent of the source concentration). These breakthrough times were calculated using a retardation factor of 165 for the gray clay, not taking any credit for movement through the brown clay, and not including any retardation in the unsaturated Great Miami Aquifer sand and gravel. The modeled breakthrough travel time for one percent of a technetium source, the FEMP's most mobile contaminant, is approximately 3.6 years. This breakthrough time was calculated using a retardation factor of 2.29 for the gray clay, not taking any credit for movement through the brown clay, and not including any retardation in the unsaturated Great Miami Aquifer sand and gravel. This modeling strategy was later used in the Operable Unit 5 Feasibility Study (FS) to calculate Waste Acceptance Criteria (WAC) for the OSDF.

The extensive presence of low permeability lean sandy clay throughout the till matrix and the discontinuous nature of the coarser grained lenses are the dominant factors controlling the rate at which fluids can migrate through the more permeable portions of till, either vertically or laterally.

Unlike conditions in the Great Miami Aquifer, the upgradient and downgradient directions of perched groundwater flow are difficult to assign at the local scale. Groundwater flow meter readings from 22 wells taken during the Predesign Investigation indicate that the horizontal flow directions vary abruptly from well to well, with no consistent patterns discernable. Consequently, horizontal flow regimes are interpreted to be very localized in nature (perhaps on the order of tens to hundreds of feet in length) and not laterally persistent due to the discontinuous nature of the interbedded coarse grained lenses. Taken collectively, the water levels obtained during the Operable Unit 5 RI indicate that if an area gradient were present it would range between 0.008 to 0.015.

Model calibration studies conducted during the Operable Unit 5 RI/FS indicate that vertical flow tends to dominate in the glacial till because of several factors: 1) the steep vertical hydraulic gradients across the till -- which are at or near unity -- compared to the small localized lateral hydraulic gradients which collectively indicate a gradient that is much less than unity (0.008 to 0.015); 2) the laterally discontinuous nature of the coarse grained lenses in the till; and 3) the shorter overall flowpath distance in the vertical dimension for the FEMP site (60 feet compared to hundreds or thousands of feet in the horizontal) before a potential discharge point for the glacial till groundwater is reached.

It can be generally interpreted from this information that if a leachate leak was able to exit through the OSDF liner system, it would be expected to migrate vertically towards the Great Miami Aquifer (although some localized "stair-step" motion laterally may also be expected to take place in route). The exact pathway(s) that a hypothetical leachate leak from the facility would take is difficult to differentiate, but it is clear that an effective monitoring program needs to consider both the most likely point of entry of the leak into the subsurface environment beneath the facility and the ultimate arrival of the leak at the Great Miami Aquifer, should it occur.

2.4 Existing Contamination

In the immediate vicinity of the OSDF, existing contaminant concentrations are present above background levels in surface and subsurface soil, the perched groundwater, and the Great Miami Aquifer. The nature and extent of contamination in these three media was documented sitewide in the Operable Unit 5 RI Report and preliminary remediation levels were developed for the FEMP's environmental media in the Operable Unit 5 FS (DOE 1995a). Final remediation levels (FRLs) were documented in the Operable Unit 5 Record of Decision.

Based on the data presented in the Operable Unit 5 RI Report, only the surface soil (to a depth of approximately six inches) is considered to be contaminated above FRLs within the actual boundaries of the OSDF. The remaining media within the OSDF footprint are contaminated above background, but generally below FRLs. An area of deep soil excavation to address deep soil and perched groundwater contamination is planned just outside the OSDF at the FEMP's sewage treatment plant, located immediately east of the OSDF. This area is the closest planned excavation necessary to address soil FRL exceedances that are deeper than six inches.

The nearest area of the Great Miami Aquifer that is contaminated above FRLs, and is thus targeted for remediation, occurs in the vicinity of Plant 6 approximately 330 feet west of the OSDF. Sporadic and isolated detections of constituents in the Great Miami Aquifer above the FRLs are observed from time to time at the FEMP's property boundary (located approximately 300 feet east of the OSDF), but these isolated detections are not considered to be part of a definitive plume requiring remediation. These detections will continue to be tracked as part of the IEMP property boundary activity.

In accordance with the Operable Unit 5 Record of Decision, remedial actions for surface and subsurface soil, the perched groundwater in the glacial till, and the Great Miami Aquifer are to be implemented at all sitewide locations where FRLs are exceeded. However, at the completion of the sitewide remedial actions, low levels of some contaminants (i.e., above background levels but below FRLs) are expected to remain in the various environmental media at the FEMP, including the area adjacent to and beneath the OSDF. This residual low-level contamination that will remain after cleanup is recognized as a factor that creates a degree of uncertainty in the ability to distinguish small quantities of potential OSDF leakage from the pre-existing levels of contamination in the media. A strategy to accommodate this uncertainty factor in the development of the monitoring plan is provided in Section 4.0.

3.0 REGULATORY ANALYSIS AND STRATEGY

The OSDF groundwater/leak detection and leachate monitoring plan is designed to comply with all regulatory requirements associated with groundwater detection monitoring and leachate monitoring for disposal facilities. The source of these regulatory requirements are the applicable or relevant and appropriate requirements (ARARs) listed in the Records of Decision for Operable Units 2, 3, and 5. This section summarizes the regulatory requirements by describing each ARAR, and presents the regulatory strategy for compliance with these ARARs.

3.1 Regulatory Analysis Process and Results

The analysis of the regulatory drivers for groundwater monitoring for the OSDF was conducted by examining the suite of ARARs in the FEMP's approved Operable Unit Records of Decision to identify a subset of specific groundwater monitoring requirements for on-site disposal facilities. Three Records of Decision include requirements related to on-site disposal -- Operable Units 2, 3, and 5. The Records of Decision for these three operable units were reviewed and the ARARs relevant to the OSDF identified. The results of this review are tabulated in Appendix A and summarized below.

The following sets of regulations were identified as being ARARs for the OSDF groundwater monitoring program:

- Ohio Solid Waste Disposal Facility Groundwater Monitoring Rules, Ohio Administrative Code (OAC) 3745-27-10, which specify groundwater monitoring program requirements for sanitary landfills. These regulations describe a three-tiered program for detection, assessment, and corrective measures monitoring.

- Resource Conservation and Recovery Act (RCRA)/Ohio Hazardous Waste Groundwater Monitoring Requirements for Regulated Units, 40 Code of Federal Regulation (CFR) 264.90 through .99 (OAC 3745-54-90 through 99), which specify groundwater monitoring program requirements for surface impoundments, landfills, and land treatment units that manage hazardous wastes. Similar to the Ohio Solid Waste regulations, these regulations describe a three-tiered program of detection, compliance, and corrective action monitoring. Because the Ohio regulations mirror or are more stringent than the federal regulations, the Ohio regulations are the controlling requirements and are cited within this document.

- Uranium Mill Tailings Reclamation and Control Act (UMTRCA) Regulations, 40 CFR 192.32(A)(2), which specify standards for uranium byproduct materials in piles or impoundments. This regulation requires conformance with the RCRA groundwater monitoring performance standard in 40 CFR 264.92. Compliance with RCRA/Ohio Hazardous Waste regulations for groundwater monitoring will fulfill the substantive requirements for groundwater monitoring in the UMTRCA regulations.

- DOE Order 5820.2A Chapter III.3.k, Environmental Monitoring, which requires low-level radioactive waste disposal facilities to perform environmental monitoring for all media, including groundwater. Compliance with RCRA/Ohio Hazardous Waste and Ohio Solid Waste regulations for groundwater monitoring will fulfill the requirement for groundwater monitoring in this Order, along with incorporating pertinent radiological parameters.

The following drivers were determined to govern the leachate monitoring plan:

- Ohio Municipal Solid Waste Rules, OAC 3745-27-06(C)(7), which requires that facilities prepare a leachate monitoring plan to ensure compliance with OAC 3745-27-19(M)(4)

- Ohio Municipal Solid Waste Rules--Operational Criteria for a Sanitary Landfill Facility, OAC 3745-27-19(M)(4)&(5), which requires submittal of an annual operational report including:

  - a summary of the quantity of leachate collected for treatment and disposal on a monthly basis during the year, location of leachate treatment and/or disposal, and verification that the leachate management system is operating in accordance with the rule, and;

  - results of analytical testing of an annual grab sample of leachate from the leachate management system.

3.2 OSDF Monitoring Regulatory Compliance Strategy

Of the ARARs presented above, the Ohio Solid Waste and the Ohio Hazardous Waste regulations are the most prescriptive, and therefore warrant further discussion on how compliance with these two regulatory requirements will be met. The leak detection monitoring requirements of these two sets of regulations are similar, and dictate the development of detection monitoring plans capable of determining the facility's impact on the quality of water in the uppermost aquifer and any significant zones of saturation above the uppermost aquifer underlying the landfill. Typically a detection monitoring program consists of the installation of upgradient and downgradient monitoring wells, routine sampling of the wells and analysis for a prescribed list of parameters, followed by a comparison of water quality upgradient of the landfill to water quality downgradient of the landfill. The detection of a statistically significant difference in downgradient water quality suggests that a release from the landfill may have occurred. As discussed in Section 2.0, low permeability and pre-existing contamination within the glacial till, and the implementation of a site-wide groundwater remedial action, add complexity to the development of a groundwater detection monitoring program consistent with the standard approach of the Solid and Hazardous Waste regulations. Both sets of regulations accommodate such complexities by allowing alternate monitoring programs, which provide flexibility with respect to well placement, statistical evaluation of water quality, facility-specific analyte lists, and sampling frequency. The OSDF groundwater/leak detection monitoring program will require the use of an alternate monitoring program, in accordance with the criteria in the Ohio Solid and Hazardous Waste regulations. Compliance with the criteria is discussed below in Section 3.2.1.

The regulatory requirements for the leachate monitoring program are provided by the Ohio Solid Waste regulations. The compliance strategy for the leachate monitoring program is discussed below in Section 3.2.2.

3.2.1 Leak Detection Monitoring Compliance Strategy

As described above and in Section 1.0, the groundwater/leak detection monitoring program for the OSDF will include routine sampling and analysis of water drawn from four zones within and beneath the disposal facility including the LCS, the LDS, perched water within the glacial till, and the Great Miami Aquifer. This four-layered "holistic" approach allows for the earliest leak detection from the OSDF given the unique hydrogeologic and pre-existing contaminant situation at the site. However, this tailored approach differs from a typical leak detection monitoring program in several ways, and requires a compliance strategy to ensure that the program meets or exceeds the substantive requirements within the Ohio Solid and Hazardous Waste regulations. Below is a detailed discussion of compliance with several elements of the program, including alternate well placement, statistical analysis, monitoring frequency, and parameter selection. The implementation of the OSDF groundwater/leak detection program is presented in Section 4.0.

3.2.1.1 Alternate Well Placement

The Ohio Solid Waste regulations require that a groundwater monitoring system consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from both the uppermost aquifer and any overlying *significant zones of saturation* (OAC 3745-27-10(B)(1)). Groundwater samples will be obtained through wells installed in the glacial till as well as the Great Miami Aquifer. The regulations also state that the wells must represent the quality of groundwater passing directly downgradient of the limits of solid waste placement (OAC 374-27-10(B)(1)(b)). In lieu of installing vertical glacial till monitoring wells along the perimeter of the OSDF, horizontal wells will be installed beneath the OSDF and screened beneath the sumps of the LDS of each disposal cell, where the greatest potential for leakage exists. Horizontal wells are preferred to vertical wells due to restrictions on well installation within 200 feet of waste placement so as to avoid interference with the disposal facility cap, and the absence of significant lateral flow within the overburden. The time required for contaminants to migrate laterally in the till toward wells located 200 feet from the limits of waste placement greatly exceeds the vertical travel time through the overburden; therefore, the aquifer would be impacted by contaminants long before OSDF glacial overburden perimeter wells could detect the release. Although the existence of the OSDF may result in dewatering of the glacial till such that samples cannot be regularly obtained, horizontal wells installed beneath the liner of the OSDF represent the highest potential for detecting releases to the till. Such an alternate placement for the till wells is allowed in the Ohio Solid Waste regulations. The performance criteria in OAC 3745-27-10(B)(4) requires that the number, spacing, and depth of the wells must be based on site-specific hydrogeologic information and must be capable of detecting a release from the facility to the groundwater at the closest practicable location to the limits of solid waste placement. The placement of till wells beneath the facility, as opposed to along its perimeter, meets or exceeds the requirement to be located adjacent to waste placement.

3.2.1.2 Alternate Statistical Analysis

A statistical analysis is required in both the Ohio Solid and Hazardous Waste regulations (OAC 3745-27-10(C)(6) and OAC 3745-54-97(H)). The statistical analysis methods listed in the regulations are: parametric analysis of variance, an analysis of variance based on ranks, a tolerance or prediction interval procedure, a control chart approach, or another statistical test method. The preferred method of evaluation for the OSDF groundwater/leak detection monitoring data is an intra-well trend analysis following the establishment of baseline conditions in the till and Great Miami Aquifer beneath the OSDF. Although vertical monitoring wells will be installed in the Great Miami Aquifer upgradient and downgradient of the OSDF, an intra-well comparison is more appropriate than an up- versus down-gradient comparison until aquifer restoration is complete. The groundwater extraction associated with the aquifer restoration will cause variation of the flow directions throughout the restoration. Initiation of pumping in the vicinity of Plant 6 will reverse the flow direction beneath the OSDF for the duration of the Plant 6 extraction operation. Transient flow conditions within the aquifer, as well as the existence and anticipated fluctuation of contaminant concentrations at levels below the final remediation levels, discourages the use of a statistical comparison of upgradient and downgradient water quality as a reliable indicator of a release from the OSDF. Once the aquifer restoration has been completed, and the hydraulic conditions in the Great Miami Aquifer have been stabilized, a standard up- versus down-gradient water quality comparison will be initiated using an appropriate statistical method.

3.2.1.3 Alternate Parameter Lists

The intra-well trend analysis discussed above will be performed for all facility-specific indicator parameters. The process used to select the indicator parameter list, described in detail in Section 4.5, utilized the extensive RI database and fate and transport modeling to evaluate potential indicator parameters. RIs have been completed for all FEMP source terms and contaminated environmental media. The RIs included extensive sampling and analysis to characterize wastes and quantify environmental contamination so that health protective remedies, such as the construction of the

OSDF, could be selected. The extensive databases were also used to develop WACs that consist of concentration- and mass-based limitations on the waste entering the OSDF. The WAC for the OSDF were developed with consideration of the types, quantities, and concentration of wastes that would be placed into the OSDF; the leachability, mobility, persistence, and stability of the waste constituents in the environment, and the toxicity of the waste constituents. Of 93 constituents that were evaluated for waste acceptance, 18 constituents were identified as having relatively higher potential to impact the aquifer within the 1000-year specified performance period. Maximum allowable concentration limits were established for wastes containing these constituents.

The factors used to establish WAC are similar to the consideration criteria for development of an alternate parameter list specified in the Ohio Solid and Hazardous Waste regulations [OAC 3745-27-10(D)(2) and (3); OAC 3745-54-93(B); OAC 3745-54-98(A)] and OEPA policy and guidance (Solid Waste Policy DDAGW-04-03-221, Interim Solid Waste Guidances GD0403.222 and GD0403.205). The methodology for developing an OSDF-specific leak detection monitoring parameter list utilized the WAC methodology and the Ohio Solid and Hazardous Waste regulatory criteria to identify waste constituents that are expected to be derived from wastes placed in the OSDF, and will be reliable indicators of a release from the OSDF.

3.2.1.4 Alternate Sampling Frequency

The Ohio Solid Waste regulations require that, for detection monitoring, at least four samples from each well be taken to determine the baseline water quality during the first 180 days after implementation of the groundwater detection monitoring program (OAC 3745-27-10(D)(5)(a)(ii)(*a*)). Implementation of the monitoring program must be initiated prior to waste receipt (OAC 3745-27-10(A)(2)(b)), presumably to ensure that at least one sample for the baseline determination is obtained before any waste is placed within the disposal facility. The Ohio Hazardous Waste regulations do not specify a frequency for determining a baseline dataset. A typical statistical test for a hazardous waste disposal facility requires an up- versus down-gradient comparison of background water quality to downgradient water quality. This type of comparison is inappropriate for the OSDF during the time period that aquifer restoration operations are underway (discussed in Section 4.3). The Ohio Hazardous Waste regulations do require a performance standard for establishing background, in OAC 3745-54-97(G), which states that the number and kinds of samples taken to establish background be appropriate for the statistical test employed. While baseline is established during the first year of monitoring, the frequency will be approximately monthly for up to 12 sampling events prior to waste placement or until waste placement is initiated. This frequency meets the Ohio Hazardous Waste performance standard and exceeds the minimum frequency requirement within the Ohio Solid Waste regulations. The monthly baseline frequency was selected so as to develop an appropriate statistical procedure and to compensate for the varying temporal conditions in the groundwater flow direction and chemistry due to the remedial action and seasonal fluctuations.

The Ohio Solid Waste regulations require a semiannual sampling frequency for detection monitoring but also allow for the proposal of an alternate sampling program (OAC 3745-27-10(D)(5)(a)(ii)(*b*) and (b)(ii)(*b*) and 3745-27-10(D)(6)). During active cell operations, the sampling frequency for the OSDF groundwater/leak detection monitoring program will be quarterly for the indicator parameters, which exceeds the semiannual frequency requirement.

3.2.2 Leachate Monitoring Compliance Strategy

The Solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate on an annual basis for parameters listed in Appendix I of OAC 3745-27-10. Leachate samples in the LCS will be collected on a quarterly basis and analyzed for parameters to support leachate treatment and discharge, as well as the annual analysis for Appendix I parameters. The annual grab sample analysis for Appendix I parameters will ensure the accuracy of assumptions regarding the nature of wastes within the OSDF that were used to develop the groundwater/leak detection parameter list. Although constituents may be detected in the annual grab that are not part of the indicator parameter list for leak detection, it is not anticipated that the concentrations will be high enough to warrant revision of the leak detection parameter list. The quarterly leachate analysis will ensure that the character of the leachate will not adversely impact the advanced wastewater treatment facility (AWWT) or the AWWT effluent receiving stream (the Great Miami River).

Although not specified in the Operable Unit Records of Decision as an ARAR, the federal RCRA (Hazardous Waste) regulations include specific requirements in 40 CFR 264.303 for monitoring the volume of liquid collected from a disposal facility's leak detection system. Regulation 40 CFR 264.302 includes provisions for determining an "action leakage rate" that, if exceeded, would prompt specific response and notification actions. After waste placement has been initiated, an "action leakage rate" will be determined (discussed in Section 4.0). The response and notification process for an exceedance of the "action leakage rate" (40 CFR 264.304) is provided in Section 6.0.

The leachate monitoring plan required by OAC 3745-27-06(C)(7) must include provisions for obtaining the monthly volume of leachate collected for subsequent treatment in the AWWT, provide the method of leachate treatment and/or disposal, and include verification that the leachate management system is operating properly (OAC 3745-27-19(M)(4)). Monitoring to verify that the leachate management system is operating properly is provided within the OSDF Systems Plan, which was first submitted with the Intermediate (60%) Design Package for the OSDF. The monthly volume of leachate collected for treatment and subsequent disposal will be obtained through a flow rate monitoring program based on the program in 40 CFR 264.303(c), which will be used as the basis for monitoring the flow rates of leachate collected in both the LCS and the LDS. Monitoring of the flow rates will provide data for determining the volume of leachate collected and will also provide data pertinent to the

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leak detection monitoring program. Because the flow rates are tied to the leak detection monitoring program, the flow rate monitoring program is described in Section 4.0. A separate leachate management monitoring plan is provided as Section 5.0 to provide information on the method of leachate treatment and/or disposal, including analysis of parameters useful for leachate treatment. Section 5.0 also includes discussion on obtaining an annual grab sample to be analyzed for Appendix I parameters, in order to comply with the requirement in OAC 3745-27-19(M)(5).

4.0 LEAK DETECTION MONITORING PROGRAM

This section presents the technical approach for leak detection monitoring at the OSDF, in light of the regulatory requirements for leak detection monitoring summarized previously in Section 3.0. The section includes a summary of the objectives of the program; a description of the major program elements; the monitoring frequencies to be employed before and after waste placement; the selection of analytical parameters; and the strategy for evaluating the data to determine whether a leak has occurred. A summary of the notifications and potential followup response actions that accompany the monitoring program is discussed in Section 6.0.

4.1 Introduction

As discussed in Section 1.0, the OSDF leak detection monitoring program constitutes the first tier of a three-tiered detection, assessment, and corrective action monitoring strategy that is required for engineered disposal facilities. Consistent with this three-tiered approach, if it is determined from this detection monitoring program that a leachate leak from the OSDF has occurred, followup assessment and corrective action monitoring plans will be developed and implemented as necessary. Conversely, if the detection monitoring successfully demonstrates that leachate leaks have not occurred, then the monitoring program will remain in the first-tier "detection mode" indefinitely. The followup assessment and/or corrective action monitoring plans, if found to be necessary, would be prepared as new, independent plans that would supersede this first-tier detection program.

The leak detection monitoring program employs a multi-component, holistic approach for leak detection, relying on the collective responses obtained from four components: an LCS inside the OSDF; an LDS inside the OSDF and below the LCS; a perched groundwater monitoring component, which will be located immediately below the LDS and LCS "sumps"; and a Great Miami Aquifer monitoring component, found at depths ranging from 45 to 90 feet beneath the OSDF. The data collected from the four components will be evaluated comparatively over time, so that short-term and long-term response relationships between the components can be effectively delineated.

Clearly, the Great Miami Aquifer is the prime resource of concern that could potentially be affected by the OSDF, in the unlikely event that a leachate leak occurred. It therefore makes prudent sense to monitor the aquifer at the immediate boundary of the OSDF to ensure the absence of impact. However, as discussed in Section 2.0, contaminant travel times to the aquifer through the glacial till beneath the OSDF are of such length that reliance on Great Miami Aquifer monitoring alone would be insufficient to provide effective early warning of a leak from the facility. The overriding intention of the "holistic" approach, therefore, is to ensure that there is no reliance on any one element alone to determine whether leakage has occurred.

As will be demonstrated in this section, the groundwater/leak detection monitoring program includes the establishment of pre-existing "baseline" conditions in the native environment underlying the OSDF (i.e., perched and Great Miami Aquifer groundwater) to be used as a point of comparison during the system-wide evaluation of trends. Following the establishment of baseline conditions, the followup sampling that will be conducted at each monitoring interval will provide a "vertical slice/snapshot in time" view of conditions that are present in each of the four components, which can then be compared to past results to determine the collective significance of trends or intermittent fluctuations in the data.

4.2 Monitoring Objectives

The fundamental objective of the leak detection monitoring program is to provide "early detection" of a leak from the facility, should one occur. Recognition of this fundamental objective will allow the FEMP to move confidently into the next regulatory-based tiers of the program -- assessment and corrective action monitoring -- should they be necessary based on detection monitoring trends. This fundamental objective is the primary driver for all of the key site-specific elements (e.g., monitoring locations, frequencies, analytical parameters, and followup response actions) of the program.

In addition to this fundamental objective, there are several other objectives that need to be considered in the site-specific design of the leak detection program:

- the program must have the ability to clearly distinguish an OSDF leak from the above-background pre-existing levels of contamination that are found in the subsurface;
- all monitoring wells must be installed at locations and with construction methods that do not interfere with or compromise the integrity of the cap and liner system of the OSDF;
- the program needs to consider the changing groundwater flow directions in the Great Miami Aquifer that will occur over time, as a result of the FEMP's aquifer restoration activities;
- the program needs to be readily implementable and not overwhelming in terms of reporting, data management, and the ability to identify trends; and
- the program needs to satisfy the site-specific regulatory requirements for leak detection monitoring summarized in Section 3.0.

The four-component leak detection monitoring approach described below meets the intent of providing early detection of a release from the OSDF within the complex hydrogeologic regime at the FEMP, and is tailored to accommodate the additional program design objectives summarized above.

4.3 Leak Detection Monitoring Program Elements

4.3.1 Overview

The success of the leak detection monitoring strategy for the OSDF is dependent upon how well the strategy integrates with facility integrity concerns (cap and liner system performance) and how well the groundwater component of the strategy addresses hydrogeologic conditions in the till and aquifer. The trends revealed by groundwater monitoring data need to be effectively integrated with leachate production information within the OSDF in order to provide a comprehensive evaluation of the OSDF performance and integrity.

The approved design for the OSDF is presented in detail in the OSDF design package (DOE, 1996a). The OSDF will consist of eight individual cells (plus a ninth contingency cell) to be constructed in phases. As shown on Figure 4-1, the liner for each cell is a composite liner system, assembled from the following layers (top to bottom): a soil cushion layer; LCS drainage layer; primary composite liner high density polyethylene (HDPE) membrane and bentonite geocomposite); LDS drainage layer; and the underlying secondary composite liner (HDPE membrane, bentonite geocomposite, and compacted clay). Both the LCS and LDS layers will each drain to the west within each cell. At the western edge of each cell liner, any liquid within the LCS and LDS is collected via extraction pipes penetrating the compacted clay liner. The points where the LCS and LDS extraction pipes penetrate the compacted clay liner are referred to as "sumps" throughout this plan. The "sumps" represent the areas with the greatest leak potential for each cell and is considered the primary location where a leak would first enter the environment if a leak were to occur.

Each cell will also be furnished with an engineered composite cover system following the cessation of waste placement. The cover system will consist of the following layers (top to bottom): a topsoil layer; an underlying subsoil layer; a granular filter layer; a bio-intrusion barrier; a geotextile filter; a cover drainage layer; the primary composite cap (geotextile cushion, geomembrane, bentonite geocomposite, and compacted clay); and an underlying contouring layer. Once the cover system is in place and the cell contents have reached equilibrium, leachate production is expected to diminish as a result of the moisture infiltration barrier properties of the cover system. During the time that the cell contents move towards equilibrium, leachate accumulation in the LCS drainage layer is expected to diminish over time.

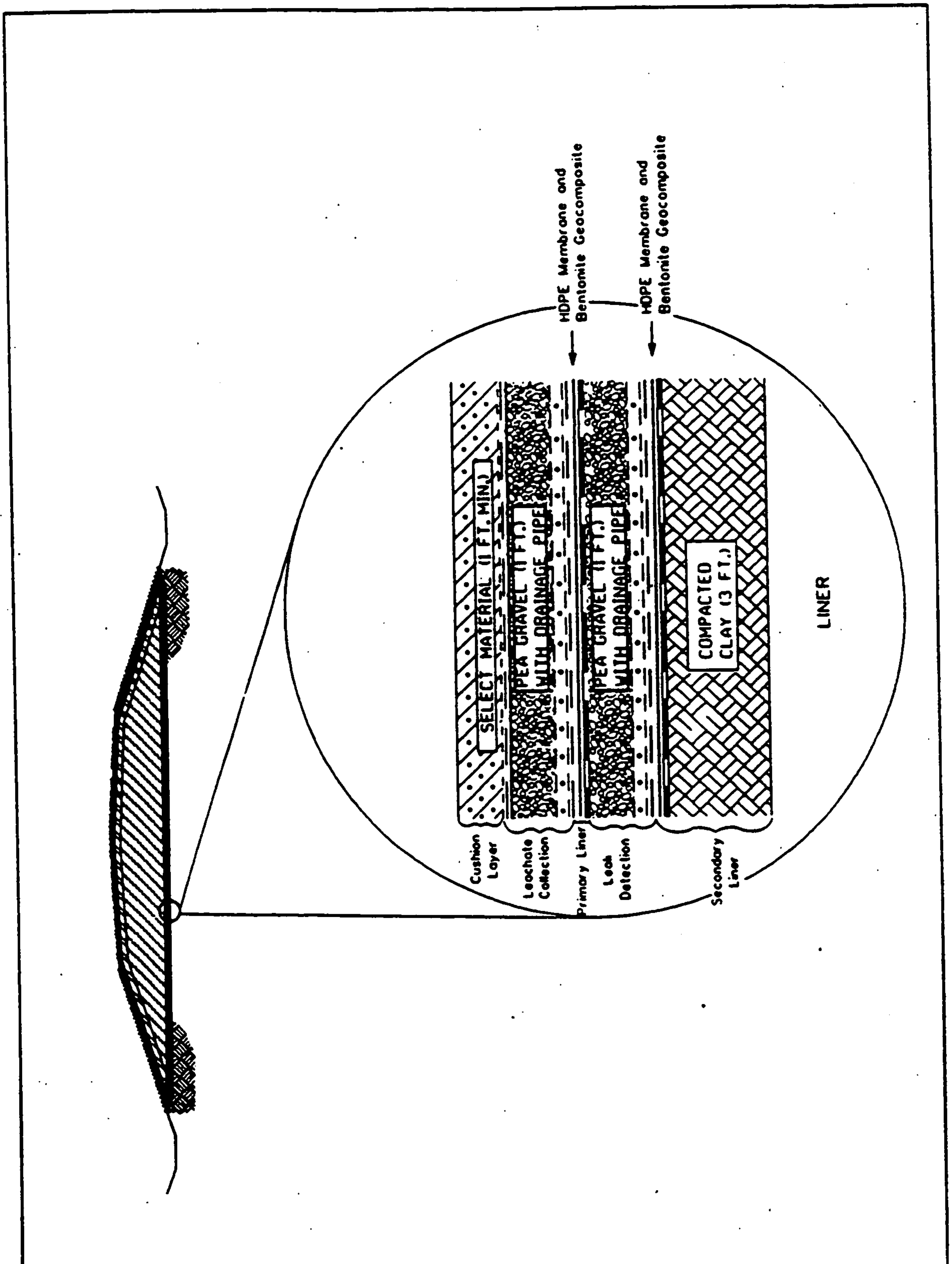

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Figure 4-1 - Composite Liner Cross Section

During active cell operations and following OSDF closure, the leak detection monitoring program will involve: 1) tracking the quantity of liquid produced within the LCS and LDS over time; and 2) the periodic monitoring of the leachate, the perched groundwater, and the Great Miami Aquifer groundwater, utilizing an identical list of site-specific analytical parameters for all three fluids to effectively implement a holistic comparative approach. The performance of each cell will be monitored individually, on its own merit; each cell will have its own engineered LCS and LDS drainage layers, perched groundwater monitoring component, and upgradient and downgradient Great Miami Aquifer monitoring wells. The four monitoring components are described below.

4.3.2 Monitoring of the Engineered Layers Within the OSDF

Water quality samples will be collected from the individual LCS and LDS drainage layers within each cell during waste placement and after cell closure. The volume of liquids routinely recovered from both the LCS and LDS drainage layers will also be recorded. The information will be used to support a collective qualitative trend analysis for each cell of the OSDF, as discussed later in this plan. A description of the LCS and LDS monitoring elements is provided below.

4.3.2.1 Leachate Collection System (LCS)

The LCS drainage layer will function primarily to collect infiltrating water (expected to be greatest during construction of the cell) to keep it from entering the environment. Infiltrating water will be greatly reduced after each cell is capped, which may subsequently limit the available sample volume and possibly affect the number of parameters that can be analyzed. The LCS will drain to the west through an exit point in the liner to a manhole located to the west of the OSDF. From there, it will flow by gravity to a lift station and be pumped to the FEMP's biodenitrification surge lagoon for subsequent treatment at the AWWT facility.

Both flow and water quality information will be collected from the LCS drainage layer according to the frequencies specified in Section 4.4, the analytical parameters specified in Section 4.5, and the procedures specified in Appendix B.

4.3.2.2 Leak Detection System (LDS)

By design, the primary composite liner located underneath the LCS drainage layer should not leak. Fluids that accumulate from time to time in the LCS drainage layer above the primary liner will be removed to further reduce the potential for leakage by minimizing the level of fluid head build up on the primary liner. Notwithstanding this design, a second fluid collection layer, the LDS drainage layer, is positioned beneath the primary composite liner to provide a means to track the integrity and performance of the primary liner. In the event that fluids collect within the LDS layer, they will drain to the west where they will be removed and routed for treatment as in the LCS.

Similar to the LCS, a greater level of fluids may initially collect in the LDS as the moisture contents of the materials comprising the primary liner move towards long-term equilibrium levels. This fluid volume would be expected to gradually decrease over the long term. Below the LDS drainage layer is a secondary composite liner comprised of an HDPE membrane, bentonite geocomposite, and compacted clay. This secondary liner serves as the lowermost hydraulic barrier in the liner system and inhibits fluids from entering the environment before they are collected and removed through the LDS drainage layer.

Like the LCS drainage layer, both liquid volume and water quality information will be collected from the LDS drainage layer according to the frequencies specified in Section 4.4, the analytical parameters specified in Section 4.5, and the procedures provided in Appendix B.

4.3.3 Perched Groundwater Monitoring in the Glacial Till

The perched groundwater monitoring component of the program is designed to monitor for the presence of leachate leakage from the OSDF at its first point of entry into the FEMP's natural hydrogeologic environment. As discussed in Section 1.0, EPA, OEPA, and DOE concur that a horizontally-oriented glacial till monitoring well, positioned directly beneath the location of the LCS and LDS drainage layer "sumps" in each cell, represents the most feasible site-specific approach to monitor for first-entry leakage from the OSDF into the FEMP's environment. A horizontal till monitoring well will therefore be furnished for each of the eight individual cells comprising the OSDF (and the ninth contingency cell, if utilized).

The horizontal monitoring wells will be installed as part of the sub-grade construction activities for each of the individual cells comprising the OSDF. This practice will ensure that the individual wells are installed prior to waste placement and eliminate final positioning uncertainties that would be associated with post-construction horizontal drilling techniques. The monitoring wells will be located along the west side of the OSDF (see Figure 4-2), and the sample collection interval will be positioned beneath the bottom of the secondary composite liner in alignment with the location of the LCS and LDS drainage layer "sumps" (see Figure 4-3).

Current lithologic and hydraulic characterization of the till in the vicinity of the OSDF indicates that the clay-rich deposits may not readily yield fluid to a well. The present amount of saturation in the till is likely to be further reduced in the future by the barrier properties of the composite cover and liner system of the OSDF, which will operate to significantly reduce local infiltration beneath the

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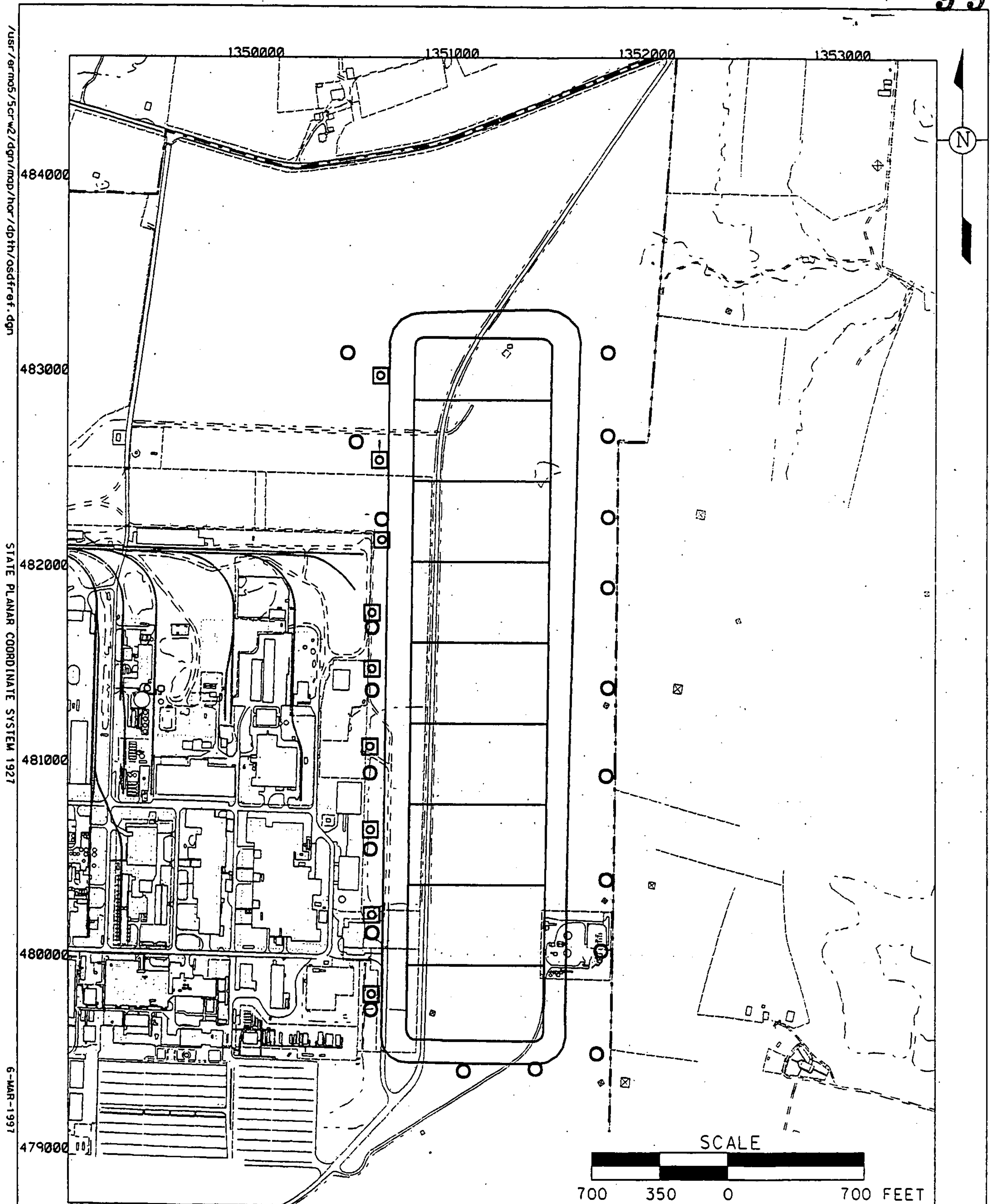

LEGEND:

○ PROPOSED OSDF GMA DETECTION MONITORING WELL

⊡ PROPOSED OSDF TILL DETECTION HORIZONTAL MONITORING WELL SAMPLING POINT

—·—·— FEMP BOUNDARY

FINAL

FIGURE 4-2. OSDF WELL LOCATIONS

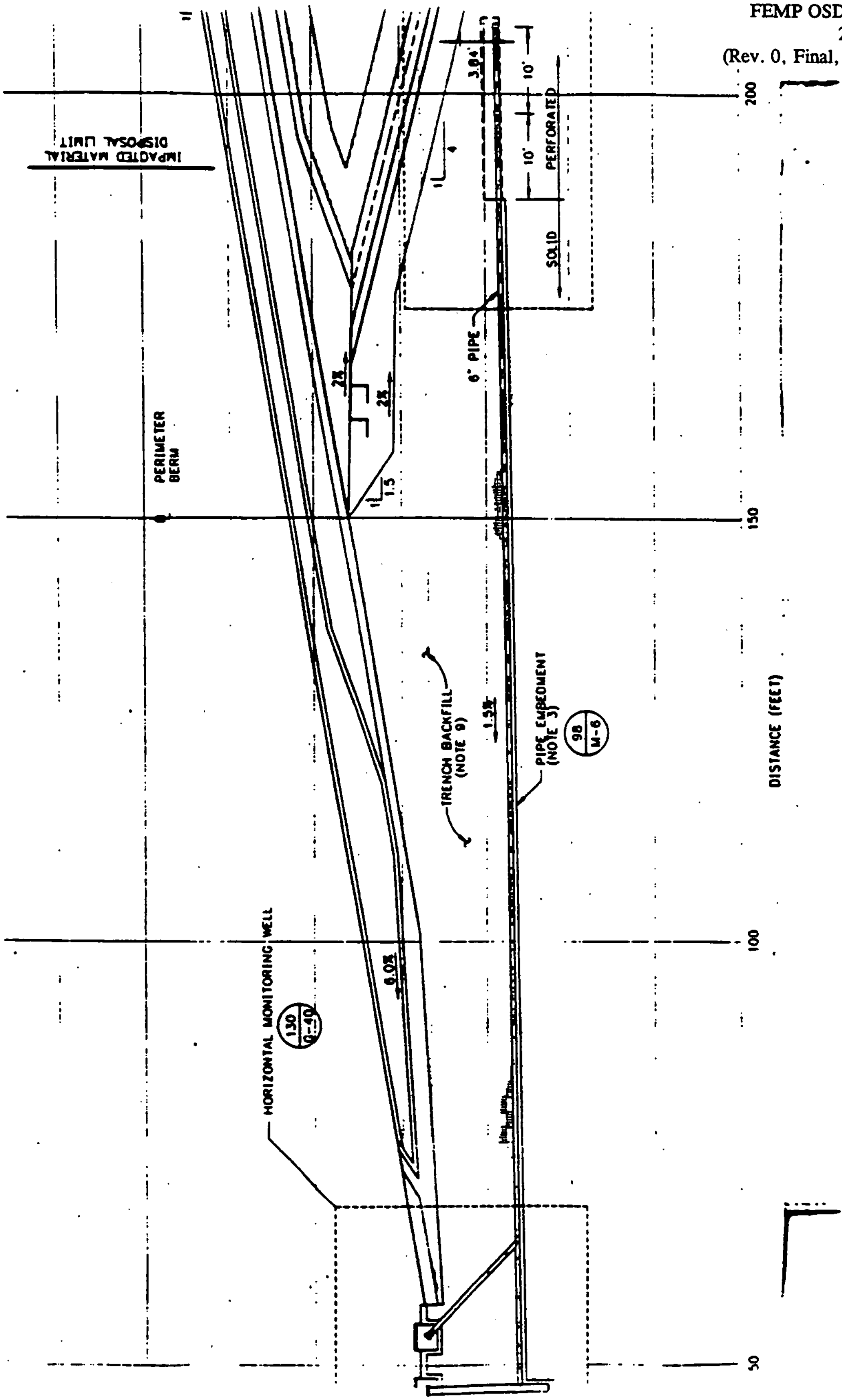

Figure 4-3 - Horizontal Till Well Cross Section

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facility. These conditions may make it impossible to obtain sufficient sample volume from the till wells to perform detailed water quality analyses. In the event sufficient sample volume cannot be obtained to perform the full list of required analyses, a priority list will be implemented as necessary on a case-by-case basis as discussed in Appendix B.

Water quality information is planned to be collected from the perched groundwater wells according to the frequencies specified in Section 4.4, the analytical parameters specified in Section 4.5, and the procedures described in Appendix B.

4.3.4 Monitoring in the Great Miami Aquifer

The sections below describe the Great Miami Aquifer component of the program, including a discussion of the influence of planned aquifer restoration activities on the program, the siting of the monitoring wells, and the use of the Sandia Waste Isolation Flow and Transport (SWIFT) computer model to evaluate the adequacy of the planned well locations.

4.3.4.1 Influence of Aquifer Restoration Activities

Restoration activities that are planned for the Great Miami Aquifer will have a bearing on the current directions of groundwater flow in the area of the OSDF. As a consequence, the requirement for conducting upgradient to downgradient well comparisons in the Great Miami Aquifer will need to consider this influence during the time that active restoration activities are underway.

The Great Miami Aquifer will be restored using a modular, area-specific, pump-and-treat approach that is presented in the Baseline Remedial Strategy Report for Aquifer Restoration (DOE, 1996a). Based on the FEMP's current plan, full restoration of all affected portions of the aquifer is projected to be complete in year 2005. During the years of active pumping, current groundwater flow directions in the Great Miami Aquifer will be modified as the various area-specific restoration modules come on line. Computer model simulations of the restoration process indicate that the current west-to-east groundwater flow direction for the aquifer in the immediate area of the OSDF will be reversed as a result of pumping from the Plant 6 Area Groundwater Restoration Module, which is scheduled to begin pumping in year 2003. The flow direction in the OSDF area will revert back to its west-to-east direction after the three years of restoration activities for the Plant 6 Area Module are complete (scheduled at the end of 2005).

While the changing flow directions that result from the aquifer restoration activities do not alter the overall placement strategy for the OSDF's Great Miami Aquifer monitoring wells, they will affect the approach to data interpretations during the time period the restoration activities are underway. The strategy for evaluating the data during this time period is discussed in Section 4.6.

4.3.4.2 Siting of the Great Miami Aquifer Monitoring Wells

The Great Miami Aquifer monitoring wells will be installed immediately adjacent to the OSDF, just outside the footprint of the final composite cap configuration so as not to interfere with the integrity of the facility. Each cell will have its own individual set of monitoring wells to assist with the evaluation of conditions associated with that cell. As each new cell is to be brought on line, its associated monitoring wells will be installed before (or concurrently with) the construction of the cell liners, so that the wells will be available for the establishment of baseline conditions prior to waste placement in that cell. The well installations will thus follow the north-to-south progression of planned construction for the OSDF cells. Once all nine potential cells are in place (including the contingency cell, if used), the OSDF will be bordered by a network of 20 Great Miami Aquifer monitoring wells that will provide the upgradient and downgradient monitoring points for the entire facility (see Figure 4-2). If the OSDF, as constructed, is a different length than currently anticipated, or the ninth cell is not utilized, the final number of Great Miami Aquifer wells may be altered in an intent to achieve the same relative positions described in this plan.

The overall objective of the Great Miami Aquifer component of the leak detection monitoring program is to provide for long-term surveillance. The current and future (post-remediation) aquifer flow conditions were therefore used to select and evaluate the 20 monitoring well locations. As discussed in the next section, groundwater flow and particle tracking using the SWIFT aquifer simulation model were used to help select the final monitoring locations provided in this plan.

All new monitoring wells will be constructed in accordance with the Sitewide CERCLA Quality Assurance Project Plan (SCQ) for Type 2 Great Miami Aquifer wells (DOE, 1992).

4.3.4.3 SWIFT Model Evaluation of Well Locations

The SWIFT groundwater modeling code was used to evaluate the adequacy of the density and locations of the monitoring wells planned for the Great Miami Aquifer. The modeling effort examined the fate of a hypothetical release from each cell to the aquifer at a point directly beneath the "sumps" of the LCS and LDS drainage layers. The groundwater model runs predicted the most likely flow path of a particle released from the "sump" area over time, and the shape and extent of a theoretical plume resulting from a release in the area of a "sump". The modeling was conducted for pre- and post-aquifer remediation conditions (when groundwater flow directions would be from west to east) and for groundwater remediation conditions in the Plant 6 area (when groundwater flow conditions would be reversed).

Particle flow path modeling was conducted using the STLINE particle tracking software with the SWIFT code. Ten particles were seeded in each of nine model grid blocks which were located nearest the nine individual-cell "sump" locations. These particles were tracked for a ten-year period with no retardation. The velocity flow field data from the pre/post-aquifer remediation scenario shows the advective particle path results (Figure 4-4). These results allowed for the placement of downgradient monitoring wells in the modeled flowpaths traced out by the particle tracks for each OSDF cell. This procedure resulted in the placement of a Great Miami Aquifer monitoring well downgradient of each OSDF cell in the most likely position to detect a leak based on anticipated groundwater flow.

During the years 2003 through 2005, the groundwater gradient in the OSDF area is predicted to be reversed due to aquifer pumping from Recovery Wells 2 and 23 in the Plant 6 area (see Figure 4-5) . The predicted groundwater velocity flow data from these three years was used to track particles from the "sump" location of each OSDF cell. Great Miami Aquifer wells on the west side of the OSDF could be located in the center of the modeled flowpaths traced out by these particles as they are drawn toward the Plant 6 aquifer remediation system. However, placing these wells in the center of the flowpaths would not necessarily produce a suitable configuration for these wells to serve as upgradient monitoring stations for the long-term post-closure care period following aquifer restoration. Therefore, the upgradient (western) wells should be placed in line with the center of each cell. This placement will be preferable for the long-term role of the wells as upgradient wells, and will be adequate for the short-term monitoring needs during the three planned years of aquifer restoration in the Plant 6 area.

The SWIFT groundwater model was used to predict if the density of downgradient GMA monitoring wells is adequate to detect the smallest contaminant plume resulting from a leak in the OSDF which would be of concern. A leak from the approximated sump location in OSDF Cell 3 was simulated for both uranium and technetium-99. Constant loading from the cell was simulated throughout the model run (using 125 foot grid spacing) such that a plume of minimum areal extent (i.e., a plume with maximum concentration equal to the FRL) was maintained in the GMA. Hypothetical plumes of 20 ppb and 94 pCi/L were maintained for uranium and technetium-99, respectively. The plumes were loaded from two hypothetical locations. One location was approximated to be below the "sump" at the western edge of Cell 3, to represent the most likely leakage point from the cell. The other location was further east, to provide a more conservative scenario where the plume would be less able to expand by the time the leading edge would reach the downgradient monitoring well.

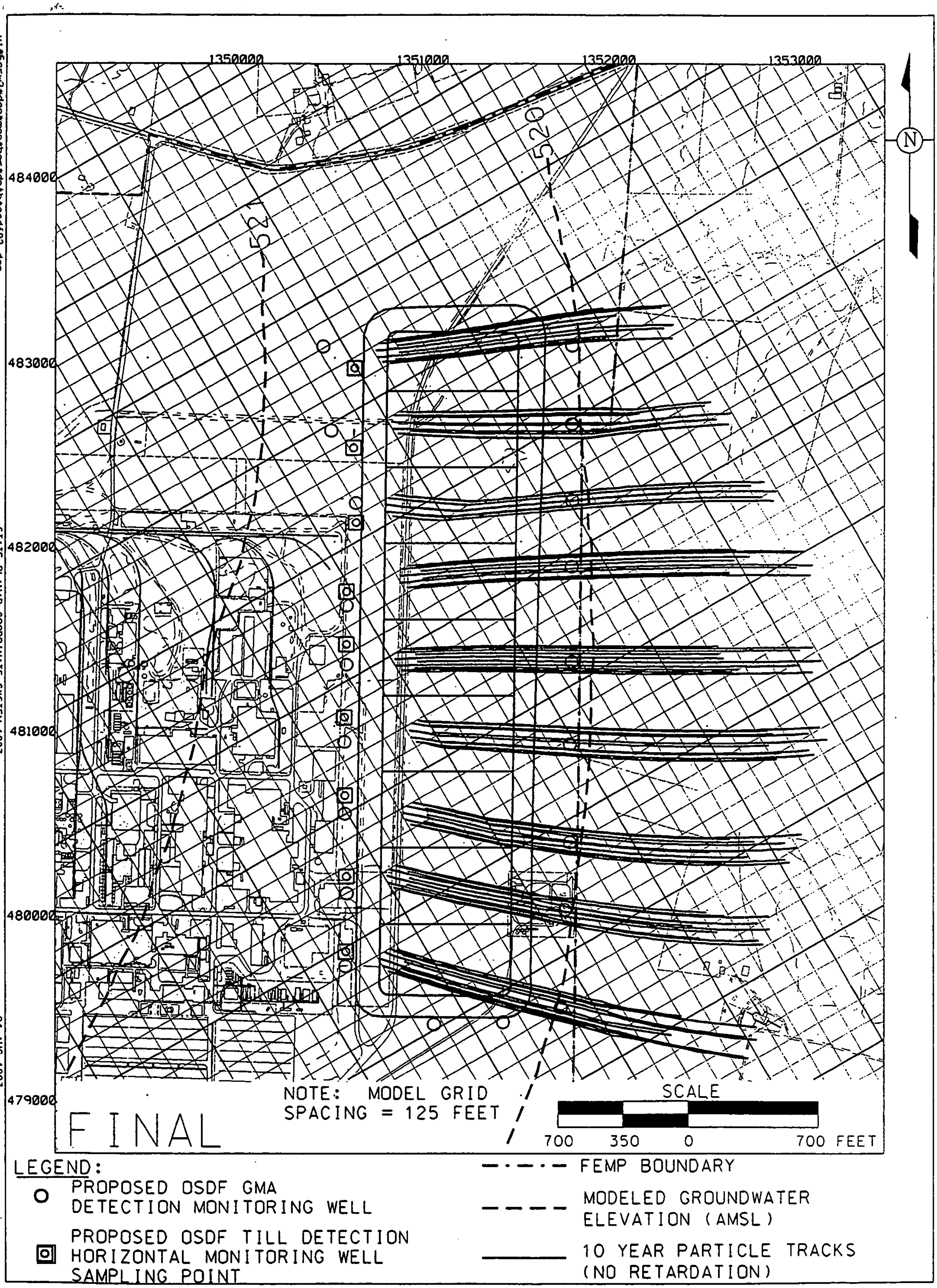

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FIGURE 4-4. POST REMEDIATION SCENARIO

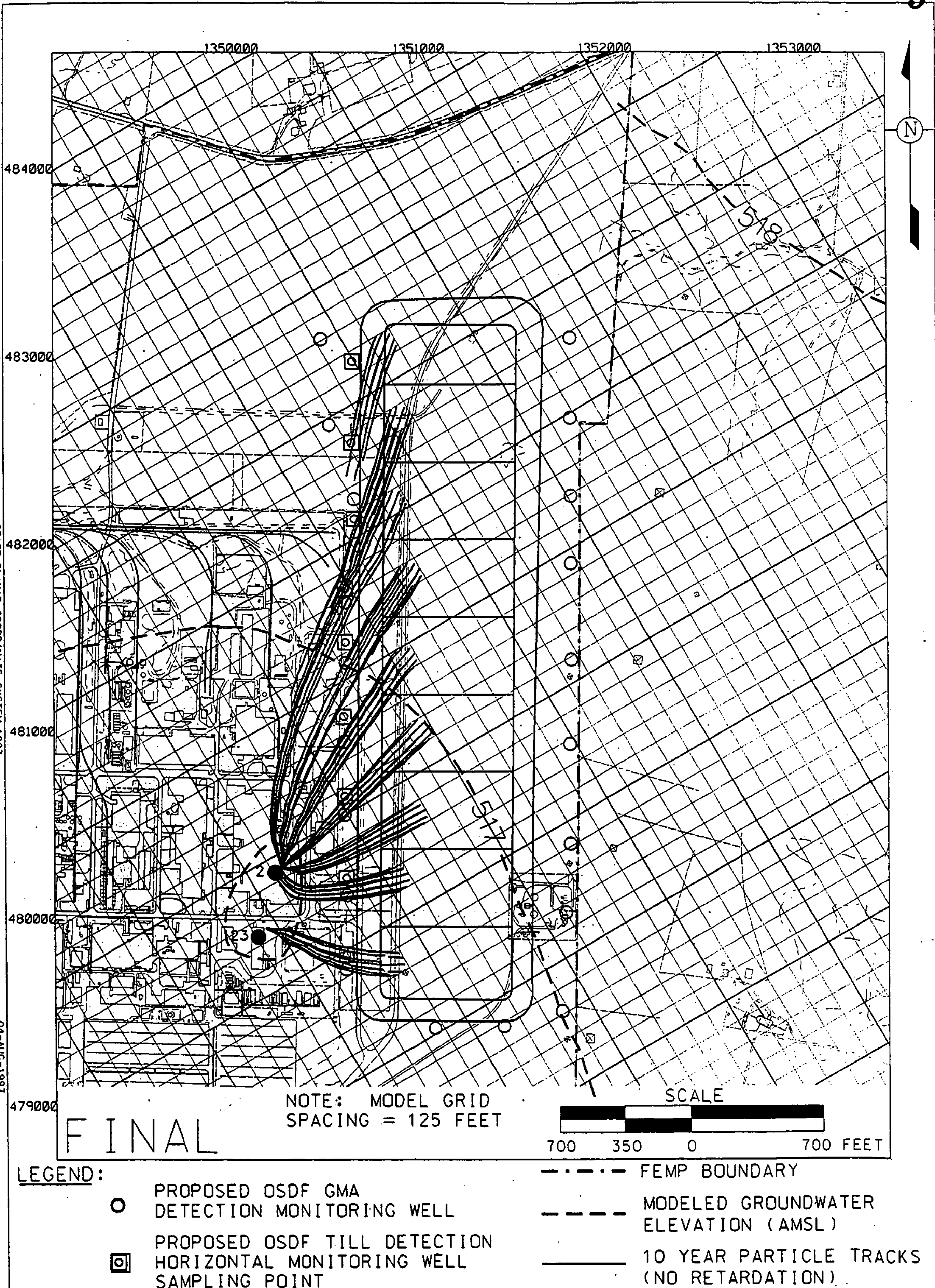

FIGURE 4-5. PLANT 6 PUMPING SCENARIO

The modeling results for uranium at model year 55 (2051) and for technetium-99 at model year 30 (2026) are shown in Figures 4-6 and 4-7, respectively. The durations were determined from the modeling, and represent the period of time under constant loading for the respective plumes to disperse to the width of the spacing distance between monitoring wells (approximately equal to the OSDF cell width). Modeling results indicate that the density of downgradient GMA monitoring wells is sufficient to detect this minimal plume given the lateral expansion and the plume width under this minimal constant loading.

The width of each plume from horizontal dispersion is approximately the width of an OSDF cell, indicating that one downgradient Great Miami Aquifer monitoring well per cell is sufficient to ensure that a Great Miami Aquifer contaminant plume would be detected. Therefore, the configuration of Great Miami Aquifer wells shown on Figure 4-2 is sufficient both in terms of well density and location for the OSDF leak detection monitoring program.

Water quality information is planned to be collected from the Great Miami Aquifer wells according to the frequencies specified in Section 4.4, the analytical parameters specified in Section 4.5, and the procedures described in Appendix B.

4.4 Leak Detection Monitoring Frequency

The following subsections discuss the sample collection frequency for the four components of the leak detection program: the LCS and LDS drainage layers, the horizontal monitoring wells in the glacial till, and the monitoring wells in the Great Miami Aquifer. The frequency of leachate production volume monitoring in the LCS and LDS drainage layers is also discussed.

The subsections discuss the sampling frequencies necessary for the establishment of baseline conditions in the perched groundwater and Great Miami Aquifer components prior to waste placement, and the sampling frequencies that will accompany all four components following the commencement of waste placement operations.

4.4.1 Establishment of Pre-Waste Placement "Baseline" Conditions

In order to accurately determine whether there has been a leak from the OSDF, it is necessary to establish representative baseline (defined for this plan as pre-waste placement) conditions in the natural environment underlying the facility, from which to draw future comparisons. As discussed in Section 2.0, both the perched groundwater system and the Great Miami Aquifer in the vicinity of the OSDF contain uranium and other FEMP-related constituents at levels above background. Many of these constituents are also members of the OSDF analytical parameter list discussed in Section 4.5. It

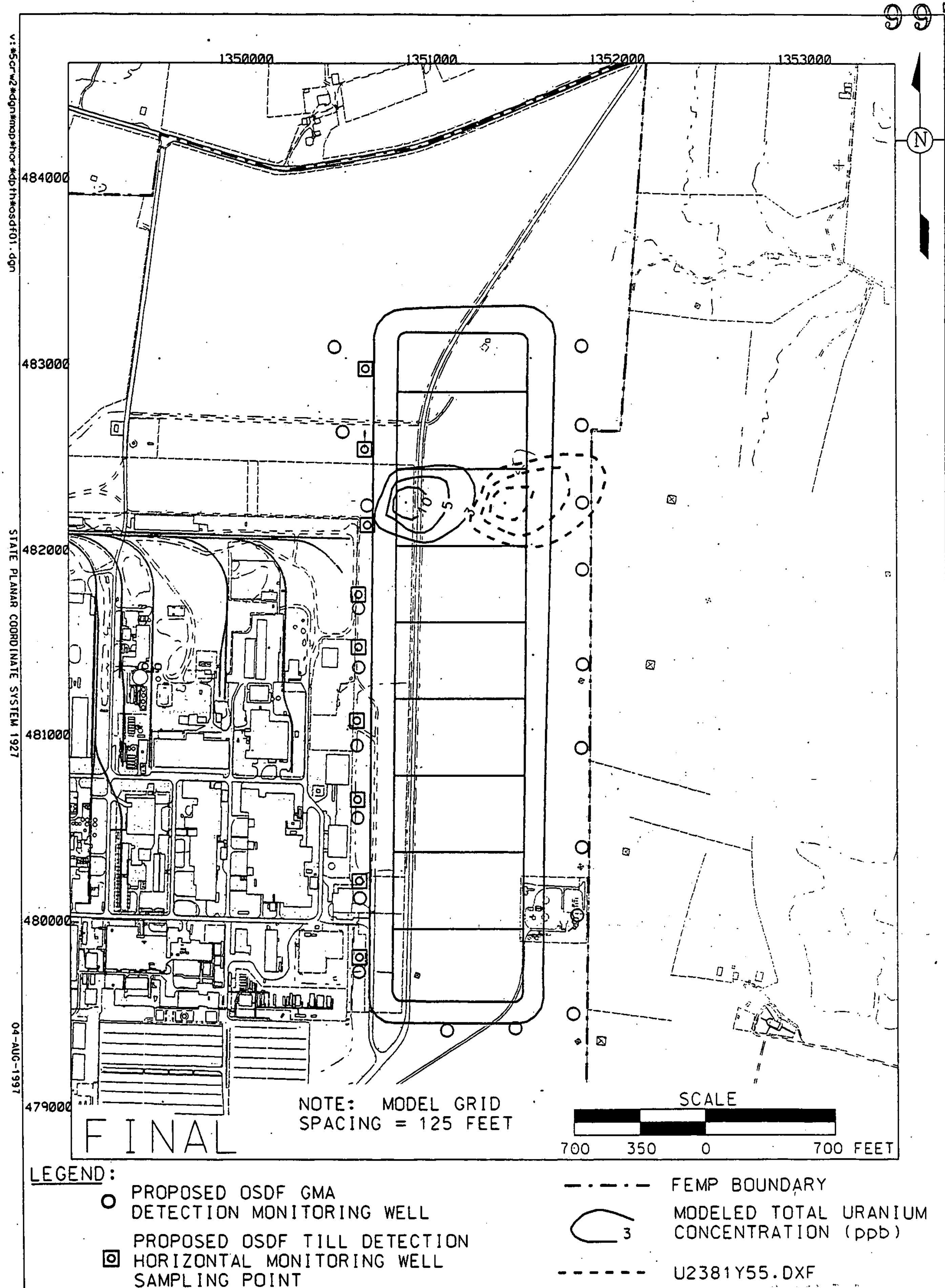

FIGURE 4-6. SWIFT MODELING WITH URANIUM LOADING - 55 YEARS

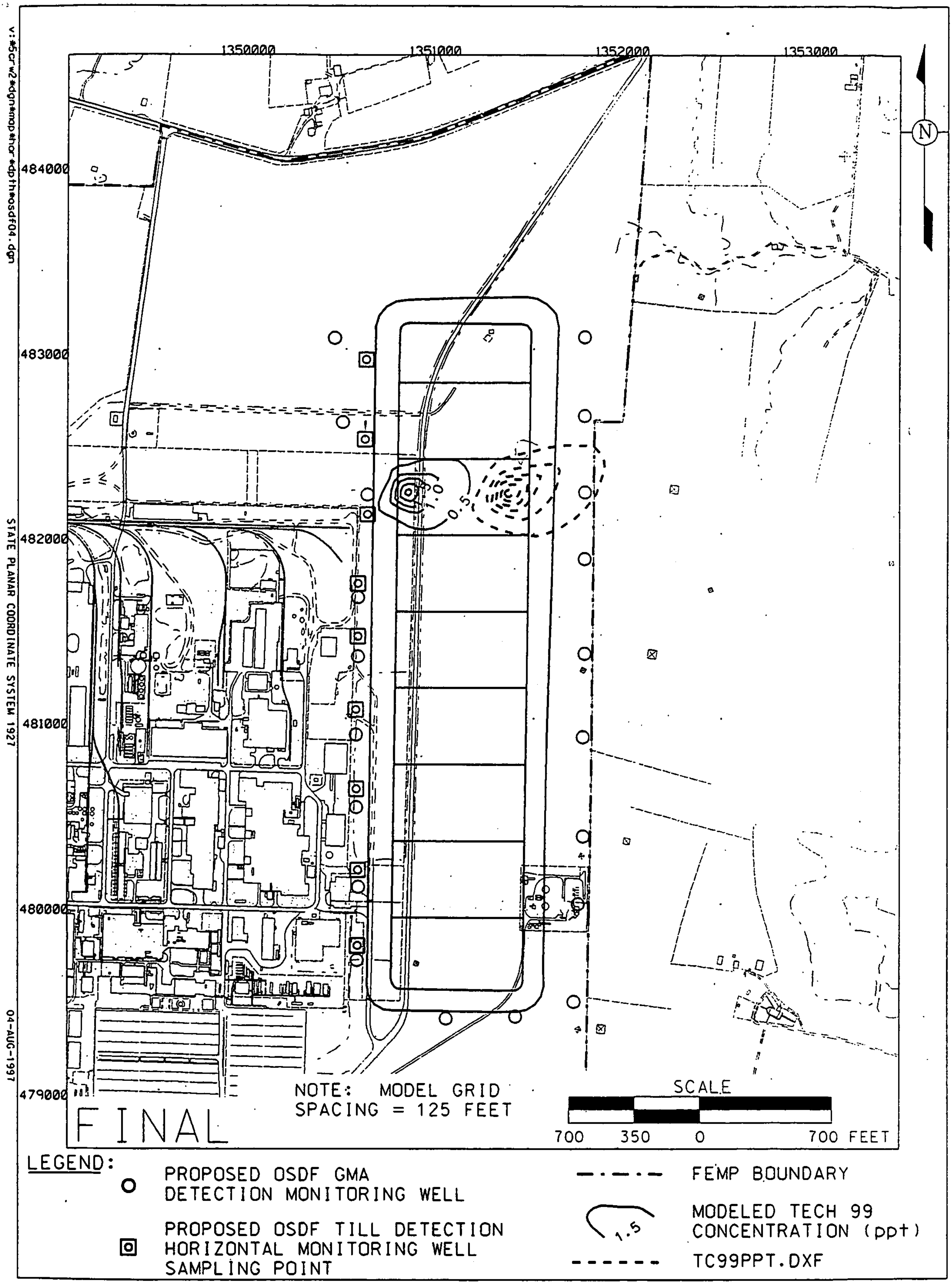

FIGURE 4-7. SWIFT MODELING WITH TECH 99 LOADING - 33 YEARS

is therefore important to establish pre-existing conditions (constituent concentration levels and variability) for all of the OSDF analytical parameters so that accurate assessments of future data trends in the perched system and the Great Miami Aquifer can be made.

The FEMP's existing information concerning pre-existing contaminant conditions in the subsurface is derived from the Operable Unit 5 RI and the OSDF Predesign Investigation. This existing information has been sufficient for the purposes of risk assessment, the development of conceptual and detailed designs for the FEMP's remedial actions, and the formulation of conservative assumptions for fate and transport modeling. The existing information is not of such detail, however, to permit the statistical evaluations, precise spatial and temporal comparisons, and comprehensive data trending that will accompany the leak detection program. More pre-waste placement information regarding data variability and seasonal influences is needed in the immediate vicinity of the OSDF for both the perched system and the Great Miami Aquifer.

The regulatory analysis presented in Section 3.0 indicates that the Ohio Solid Waste regulations require that groundwater monitoring at a disposal facility be initiated prior to waste placement, and at least four samples be obtained to define background conditions. At least one of these samples must be collected prior to waste placement, and the remainder must be collected within 6 months of waste placement initiation. Based on the current understanding of pre-existing levels of contaminants in the OSDF subsurface, the FEMP is electing to perform up to 12 rounds of baseline sampling (prior to waste placement) for both the perched system and the Great Miami Aquifer for all of the site-specific analytical parameters specified in Section 4.5. The intent of the 12 sampling events is to procure enough data to be able to accurately forecast the variability in pre-existing levels of site constituents that are known to be above background. Generally, one sampling round per month is envisioned wherever possible, although the frequency will be modified as necessary to accommodate the most current projection of the waste placement schedule for each individual cell.

For both the perched groundwater and Great Miami Aquifer wells, once the data from the initial sampling events have been procured, DOE will evaluate whether sufficient information is available to ascertain the variability and type of distribution that is present in the data (e.g., parametric or non-parametric distributions) at a level precise enough to move forward with active cell monitoring. At this juncture, an appropriate statistical method and associated statistical measure to establish pre-existing baseline conditions will be selected and documented as an addendum to this plan. This identification is anticipated to be made on an individual parameter-, monitoring point-, and cell-specific basis for both the perched groundwater and Great Miami Aquifer components of the program. If the amount of data is insufficient for this purpose, additional baseline samples will be collected, again prior to waste placement. The initial planned sampling intervals will be scheduled far enough in advance of waste placement to allow for additional sampling if necessary to augment the baseline database.

In the event that one or more monitoring points (for example, the perched water wells) produce insufficient water volume for sampling the full suite of analytical parameters, the data accumulation period for establishing that monitoring point's baseline might need to be extended (at a sampling frequency independent of the frequency for the other monitoring points which have a baseline) until sufficient data are obtained for that monitoring point.

This approach exceeds the minimum State of Ohio regulatory requirements for background sampling and should provide the FEMP with sufficient information to conduct future comparative evaluations.

4.4.2 Monitoring Frequency During Active Cell Operations

Once baseline conditions have been established for the perched and Great Miami Aquifer groundwater components and waste placement operations commence in an individual cell, the flow and water quality monitoring frequencies for the four components will follow the guidelines described below.

4.4.2.1 Flow Monitoring in the LCS and LDS

Leachate collected by the LCS from each cell flows by gravity to the leachate transmission system (LTS) permanent lift station. Anticipated leachate production rates in the LCS were determined during the design of the OSDF (see Section 7.1 of the OSDF Calculation Package) as follows:

	LCS, each cell, gallons per acre day		LCS baseline design flow rate per cell, gallons per day
	Average	Peak	
Initial stage (10 ft. or less waste)	1145	1754	11401
Intermediate stage (>10 ft. of waste)	696	1754	
After closure	0.002	0.024	0.16

The initial stage is when construction of the liner system has been completed and waste placement starts and continues until 10 feet of waste has been placed in the cell. The intermediate stage is the placement of waste from the initial 10 feet of waste until cell closure. After closure is the period after the cell has been capped.

The amount of liquids removed from the OSDF via the LCS will be recorded in accordance with the following graded approach. This graded approach is patterned after federal hazardous waste landfill regulations 40 CFR 264.303(c)(2), which also satisfies Ohio solid waste rule OAC 3745-27-19(M)(4)]:

Tier	LCS Flow Monitoring Frequency
	PRIOR TO PLACEMENT OF FINAL COVER ON THE LAST OSDF CELL
0	Record at least monthly.
	POST CLOSURE (AFTER PLACEMENT OF FINAL COVER ON THE LAST OSDF CELL)
1	Record at least monthly, except as provided by the following.
2	If the liquid level stays below the "pump operating level" for two consecutive months, record at least quarterly, except as provided by the following.
3	If the liquid level stays below the "pump operating level" for at least two consecutive quarters, record at least semi-annually.

NOTE: The post-closure point of measurement is the LTS permanent lift station sump. If at any time during the post-closure care period the "pump operating level" is exceeded when on quarterly (Tier 2) or semi-annually (Tier 3) recording schedule, the recording schedule will revert to monthly (Tier 1) until the requirement is met to move to the next higher numbered tier.

"Pump operating level" is that liquid level based on pump activation level, sump dimensions, and the level that avoids backup into the LCS drainage layers in the OSDF cells, and minimizes head in the LTS permanent lift station sump. "Pump operating level" for the LTS permanent lift station sump is to be developed later (as an amendment to this plan, as discussed in Section 6.0) after the final cover has been placed over the last cell of the OSDF. It is anticipated that this will be established via trend analysis on leachate flow monitoring measurements prior to and after closure of the last cell of the OSDF.

Additionally, trend analysis of these LCS flow monitoring measurements will be conducted in order to provide indication of changes in trends in system performance far enough in advance to allow application of appropriate follow-up inspection and corrective action as necessary. The required notifications and response actions for leachate flow monitoring are discussed in Section 6.0.

The amount of liquids removed from each LDS primary containment vessel manhole will be recorded in accordance with the following graded approach, consistent with the approach for the LCS:

Tier	LDS Manhole Primary Containment Vessel Flow Monitoring Frequency
	PRIOR TO PLACEMENT OF FINAL COVER ON AN INDIVIDUAL OSDF CELL
0	Record weekly.
	POST CLOSURE (AFTER PLACEMENT OF FINAL COVER ON AN INDIVIDUAL OSDF CELL)
1	Record at least monthly, except as provided by the following.
2	If the liquid level in the LDS manhole primary containment vessel stays below the "action leakage rate" for two consecutive months, record at least quarterly, except as provided by the following.
3	If the liquid level in the LDS manhole primary containment vessel stays below the "action leakage rate" for at least two consecutive quarters, record at least semi-annually.

NOTE: These are intended to apply individually to each cell of the OSDF. If at any time during the post-closure care period the "action leakage rate" is exceeded at a cell on quarterly (Tier 2) or semi-annually (Tier 3) recording schedule, the recording schedule for that cell will revert to monthly (Tier 1) until the requirement is met to move to the next higher numbered tier.

The configuration of the LDS manholes are shown in OSDF Construction Drawing sheet M-6A. "Action leakage rate" is that liquid level based on LDS manhole primary containment vessel dimensions, and the level that avoids backup into the LDS drainage layer and minimizes head in the LDS manhole. "Action leakage rate" for each LDS manhole is to be developed later (as a future amendment to this plan, as discussed in Section 6.0) based upon measurements after the final cover has been placed over that cell. It is anticipated that this "action leakage rate" will be established via trend analysis on closed cells prior to closure of the last cell of the OSDF.

Additionally, trend analysis of the LDS flow monitoring measurements will be conducted in order to provide indication of changes in trends in system performance far enough in advance to allow application of appropriate follow-up inspection and corrective action as necessary. The required notifications and actions are discussed in Section 6.0.

4.4.2.2 Water Quality Monitoring in the LCS and LDS

The frequency of water quality monitoring for the LCS and LDS drainage layers within each cell, for leak detection monitoring purposes during active cell operations, will be quarterly. Samples will be collected from the LCS cleanout and the LDS primary containment vessel. The samples will be analyzed for the parameters contained in Section 4.5.

Prior to collecting the sample, the volume contained in the LCS manhole and the LDS primary containment vessel will be estimated to determine if sufficient volume is present for the full suite of analytes (see discussion in Appendix B for the setting of priorities). In the case of an absence of liquid in the LCS and/or LDS drainage layers such that water quality sampling cannot be conducted, it will be inferred that no leak from the cell has occurred.

While it is desired that the samples be collected from the LCS and LDS at the same time interval to enhance the comparability of the data, the overriding requirement is that enough fluid be is present in the individual system to collect sufficient volume for the analyses.

4.4.2.3 Perched Groundwater and Great Miami Aquifer Water Quality

After the perched groundwater and Great Miami Aquifer baselines are established and waste placement operations have begun, the groundwater monitoring wells for both of these components will be sampled quarterly, to address the potential for seasonal variation in the analytical parameters. Four quarters of sampling over one year are generally accepted for providing seasonal variation in groundwater chemistry. Because of the existing contamination in the Great Miami Aquifer and the perched groundwater and the current remediation underway site-wide, the sampling frequency will be quarterly until future conditions warrant otherwise (see Section 4.4.3 below). Section 4.5 discusses the analytical parameters to be utilized for both components.

Sampling both the perched groundwater and the Great Miami Aquifer groundwater during the same time frame is desired to enhance the comparability of the data; however, the overriding requirement is that enough fluid be present in the individual monitoring point to collect sufficient volume for the analyses.

Prior to collecting the sample, the volume contained in the monitoring point will be estimated to determine if sufficient volume is present for the full suite of analytical parameters (see Appendix B for a discussion on setting priorities for low sample volume). The sufficiency of volume is of particular concern in the till monitoring point; if no liquid is found in the till monitoring point, it will be inferred that no leak from the cell has occurred. However, if water exists in the well, it will not be directly inferred that a leak has occurred, and water volume measurements will be taken and plotted versus time to assist in the holistic approach of determining a leak.

4.4.3 Future Considerations

The previous sections discussed the monitoring frequencies to be employed during the establishment of baseline conditions and during active cell operations. Two additional conditions will occur in the future that may require the monitoring frequency for any or all of the four leak detection components to be reevaluated:

- final capping of the individual cells, which will generally result in a decrease in the overall quantity of leachate produced and a potential corresponding change in leachate composition; and

- completion of restoration activities for the Great Miami Aquifer, and the return of groundwater flow directions to pre-restoration conditions.

Section 4.6 discusses the manner in which the leak detection program data will be evaluated during the time period that aquifer restoration activities are underway and upgradient to downgradient comparisons of Great Miami Aquifer data are not possible. It is envisioned that following the completion of the restoration activities and the return of groundwater flow directions to their natural state, upgradient to downgradient comparisons will be formally initiated and continued indefinitely following closure of the OSDF. At the completion of aquifer restoration activities and the return of flow conditions to a more stable condition, it may be beneficial to increase the frequency of sampling from the Great Miami Aquifer for an intervening period to more comprehensively establish upgradient conditions prior to the formal implementation of the upgradient and downgradient statistical comparisons. After upgradient conditions are established through a more frequent sampling interval (if used), a reduction of the sampling frequency to semiannual will be considered, particularly if the quarterly sampling results do not reveal any seasonal variation beyond what would be revealed by semiannual sampling results. The need for (and scope of) this frequency modification will be evaluated once aquifer restoration activities are terminated. An amendment to this plan would be developed at that time to accommodate any modifications.

It may also be beneficial to increase the frequency of sampling from the LCS and LDS layers, and perhaps the groundwater components as well, for an intervening period once the final cap on an individual cell is installed. This could potentially facilitate a more comprehensive tracking of the changes in leachate quality (and changes in perched groundwater quality because of reduced moisture contents in the underlying till) that accompany the reduced infiltration rates associated with the placement of the final cap and closure of the cell. As with the possible modification listed above, the need for (and scope of) this frequency modification will be evaluated once waste placement is near completion in the first cell and the data compiled to date from all four of the leak detection monitoring components have been fully evaluated. An amendment to this plan would be developed at that time to accommodate any modifications.

4.5 Selection Of Monitoring Parameters

As discussed in the regulatory analysis provided in Section 3.0, a successful leak detection monitoring program must focus on the best indicators of potential releases, as opposed to analyzing for every possible constituent that may be present in a disposal facility (which would not be manageable and would add unnecessary complexity to the data analysis process). This section presents the criteria and process used to identify the site-specific indicator parameters for the OSDF groundwater leak detection monitoring program. The selected indicator parameters will supplement the leachate flow monitoring conducted in the LCS and LDS layers (described in Section 4.4) to promote the early detection of potential leaks from the facility.

4.5.1 Guidelines for Site-Specific Monitoring Parameter Selection

At the FEMP, statistically significant deviations from current groundwater conditions are anticipated throughout the remediation period, as pre-existing contamination in the aquifer is removed and flow directions change in response to the groundwater remediation being undertaken at the FEMP. Additionally, residual contamination in soil is expected to move through the glacial till and impact the aquifer at concentrations below the groundwater FRLs, but statistically elevated above current background conditions, for several years.

It is important to recognize that all of the inorganic constituents and all but nine organic constituents included in the regulatory default monitoring parameters list (i.e., Appendix I of OAC 3745-27-10) have been detected in perched groundwater samples collected at various locations under the FEMP. Such pre-existing contamination in the environment beneath the OSDF along with aquifer remediation activities add complexity to the development of a successful leak detection parameter list capable of indicating the presence of a leak from the OSDF. Therefore a tailored leak detection parameter list must be developed that provides adequate leak detection and that is in compliance with the standard requirements of the Ohio Solid Waste Rules and the Ohio Hazardous Waste Rules. As discussed in Section 3.0, both sets of rules allow the use of an alternate monitoring parameter list based on site-specific conditions.

Ohio Solid Waste regulations OAC 3745-27-10(D)(2)&(3) allow six considerations in proposing an alternate monitoring parameter list in lieu of some or all of the parameters listed in Appendix I of OAC 3745-27-10. Also, the Ohio Hazardous Waste regulations for new facilities, OAC 3745-54-98(A), recognizes four considerations in formulating the facility-specific monitoring parameter list.

Table 4-1 summarizes the important considerations and approval criteria related to monitoring parameter selection under the Ohio Solid Waste and Ohio Hazardous Waste regulations.

Table 4-1
Regulatory Criteria for Alternate Parameter List

Ohio Solid Waste Regulation	Ohio Hazardous Waste Regulation
REQUIREMENTS:	
• for all parameters, the removed parameters are not reasonably expected to be in or derived from the waste contained or deposited in the landfill facility; and [OAC 3745-27-10 (D)(2)]	—
• for inorganic parameters, the approved alternative monitoring parameter list will provide a reliable indication of inorganic releases from the landfill facility to the groundwater. [OAC 3745-27-10 (D)(3)]	indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in groundwater. [OAC 3745-54-98 (A)]
CONSIDERATIONS:	
• types, quantities, and concentrations of constituents to be managed at the facility; [OAC 3745-27-10 (D)(2)(b) & (D)(3)(a)]	types, quantities, and concentrations of constituents to be managed at the regulated unit; [OAC 3745-54-98 (A)(1)]
• mobility, stability, and persistence of the waste constituents or their reaction products in the unsaturated zone beneath the facility; [OAC 3745-27-10 (D)(3)(b)]	mobility, stability, and persistence of the waste constituents or their reaction products in the unsaturated zone beneath the waste management area; [OAC 3745-54-98 (A)(2)]
• concentrations in the leachate from the relevant unit(s) of the facility; [OAC 3745-27-10 (D)(2)(c)]	—
• detectability of the parameters, waste constituents, and their reaction products in the groundwater; [OAC 3745-27-10 (D)(3)(c)]	detectability of the indicator parameters, waste constituents, and their reaction products in the groundwater; and [OAC 3745-54-98 (A)(3)]
• concentrations or values and coefficients of variation of monitoring parameters or constituents in the background [baseline] groundwater quality; and [OAC 3745-27-10 (D)(3)(d)]	concentrations or values and coefficients of variation of monitoring parameters or constituents in the background [baseline] groundwater quality. [OAC 3745-54-98 (A)(4)]
• any other relevant information. [OAC 3745-27-10 (D)(3)(c)]	—

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It is important to point out that the chemical constituents listed in Appendix I of OAC 3745-27-10 are typical contaminants found in sanitary landfills. Appendix I does not include any radionuclides which are the primary contaminants of concern at the FEMP. Therefore, any FEMP-specific constituents not included in Appendix I of OAC 3745-27-10 but that are good indicators of potential leaks from the OSDF also need to be evaluated in the parameter selection process. However, the general considerations summarized in Table 4-1 can apply to any constituents when selecting the leak detection indicator parameters.

Parameter selection in this initial version of the OSDF groundwater monitoring plan is intended to focus on establishing the baseline conditions for the individual cells of the OSDF (i.e., up to 12 monitoring events prior to waste placement). Parameters in this initial baseline sampling and analysis approach of the OSDF groundwater monitoring program are selected using site-specific contamination data generated during the previous RI/FS processes in accordance with the regulatory considerations presented above.

The remainder of this section presents the site-specific monitoring parameters list, corresponding to an alternate monitoring parameters list as defined in the regulations. Although being proposed as an initial list, these indicator parameters will likely provide sufficient and reliable indication of potential releases throughout the active operation of the OSDF. However, future considerations for potential modifications of the parameter list are also discussed at the end of this section.

4.5.2 Initial Leak Detection Monitoring Parameters List

An alternate leak detection monitoring parameters list should include both primary (i.e., chemical-specific) parameters and supplemental indicator parameters. As suggested by the regulatory considerations summarized in Table 4-1, primary parameters should consist of selected site-specific chemical constituents which are expected to be of significant amounts in the monitored facility, and which are persistent, mobile, and differentiable from existing background conditions when released. The supplemental indicator parameters may include general groundwater quality parameters which will have rapid and detectable changes in response to variations in chemical compositions in groundwater under the monitored facility, potentially as a result of a leak.

Fourteen (14) primary parameters and four supplemental indicator parameters are proposed for the initial groundwater leak detection monitoring for the OSDF. Samples collected in the perched groundwater and Great Miami Aquifer monitoring wells for the initial baseline analyses as well as samples collected in all four monitoring components during and after waste placement will be analyzed for these 18 parameters according to the frequency specified in Section 4.4. This subsection presents the rationale for the selection of the primary and supplemental indicator parameters.

4.5.2.1 Primary Parameters

In general, organic constituents are more mobile but less persistent than most inorganic constituents and radionuclides. Because inorganic constituents and most radionuclides are present in natural soil, if the OSDF was constructed in a pristine site, organic constituents may be the preferred primary monitoring parameters for early leak detection purposes. However, because all three types of constituents have been detected in the media (i.e., perched groundwater and the Great Miami Aquifer), in order to be differentiable from background conditions in case of a release, a good leak detection monitoring parameter must also be present in significant abundance or at relatively high source strengths in the OSDF.

Constituent-specific quantity, persistence, and mobility data have been considered during the development of the WAC for the OSDF. Therefore, information from the OSDF WAC development process was first reviewed to select the primary parameters for leak detection monitoring purposes. The WAC for the OSDF were developed for 42 constituents during the Operable Unit 5 FS; 41 of the WAC are included in the final Operable Unit 5 Record of Decision (as discussed later, one compound, magnesium, was eliminated following completion of the FS). As will be discussed in this section, 18 of the 41 WAC are numerical limits and 23 are non-numerical limits that were established to satisfy regulatory screening criteria for RCRA-regulated constituents.

The maximum acceptable leachate concentrations for constituents that will be present in the OSDF were determined by fate and transport modeling. The constituent-specific leaching potential, solubility, mobility and benefits of the engineering controls in the OSDF were considered in the modeling process. These maximum acceptable leachate concentrations were converted into solid phase WAC at the end of the process. These solid phase WAC represent the maximum concentrations for soil and debris that can be disposed of in the OSDF.

To assist in selecting the primary parameters, the actual soil concentrations for each of the 18 Constituents of Concern (COCs) for which numerical WAC were developed are also reviewed to provide a clear perspective regarding which COCs may approach their corresponding WAC concentrations and therefore are more likely to be detectable when released from the OSDF.

During the Operable Unit 5 FS, two categories of COCs were evaluated in the WAC development process. The first category includes all of the site-specific groundwater pathway COCs that were identified in the Operable Unit 5 RI. As a result of the process, 12 numerical WAC were developed for the groundwater pathway COCs. The second category includes those FEMP constituents which need to be managed and accounted for under RCRA regulations. Six additional numerical WAC were developed for the RCRA regulated constituents, bringing the total numerical WAC for the OSDF to 18.

The following subsections summarize the WAC development process for these two categories of constituents, as derived from the sitewide WAC development process described in the Operable Unit 5 FS. Figure 4-8 summarizes the process in flow chart fashion.

4.5.2.1.1 Groundwater Pathway COCs

Initially, only the WAC for groundwater pathway COCs were developed. WAC were determined necessary for 15 groundwater pathway COCs selected from Table F.2-2 of Appendix F of the Operable Unit 5 FS. Among all the detected soil and groundwater constituents at the FEMP, these 15 COCs have potential to reach and impact the Great Miami Aquifer through the glacial till under natural conditions (i.e., before being disposed in the OSDF) within 1000 years. Table F.2-2 also lists all the other constituents screened for potential cross-media impacts. Overall 53 organics, 25 inorganics, and 15 radionuclides were evaluated in the groundwater COC selection process, including all the RCRA constituents that have been detected in soil and groundwater at the FEMP.

After considering the engineering controls provided by the OSDF in the modeling procedures, 12 of the original 15 groundwater pathway COCs were found to require a numerical WAC. Compliance with the 12 numerical WAC, when determining what materials can be disposed in the OSDF, will be required for long-term protection of the Great Miami Aquifer. Table 4-2 lists the 15 COCs considered and the WAC that were developed. The technical approach of fate and transport modeling conducted to develop the COC-specific WAC has been summarized in Section F.5 in the Operable Unit 5 FS.

Upon further review of the initial WAC development process contained in the Operable Unit 5 FS, EPA, OEPA, and DOE concurred that magnesium does not present a significant threat to human health. Therefore, magnesium was eliminated from further consideration and a WAC for magnesium was not presented in Table 9-6 of the Operable Unit 5 Record of Decision.

The numerical WAC for the 12 groundwater pathway COCs will likely be the main controlling factors for the disposal of contaminated soil in the OSDF. The 12 groundwater pathway COCs which have numerical WAC have significantly higher mobility and persistence, and therefore should be considered as prime candidates when selecting the indicator parameters for the detection monitoring program for the OSDF.

The numerical WAC for the 12 groundwater pathway COCs in Table 4-2 only define the maximum allowable soil concentrations that can be safely disposed in the OSDF; they do not indicate what level of soil concentrations will actually be encountered during soil remediation. In order to frame the relative significance of these 12 WAC, the maximum soil concentrations for the 12 constituents that are expected in the OSDF following soil placement are provided in Table 4-3.

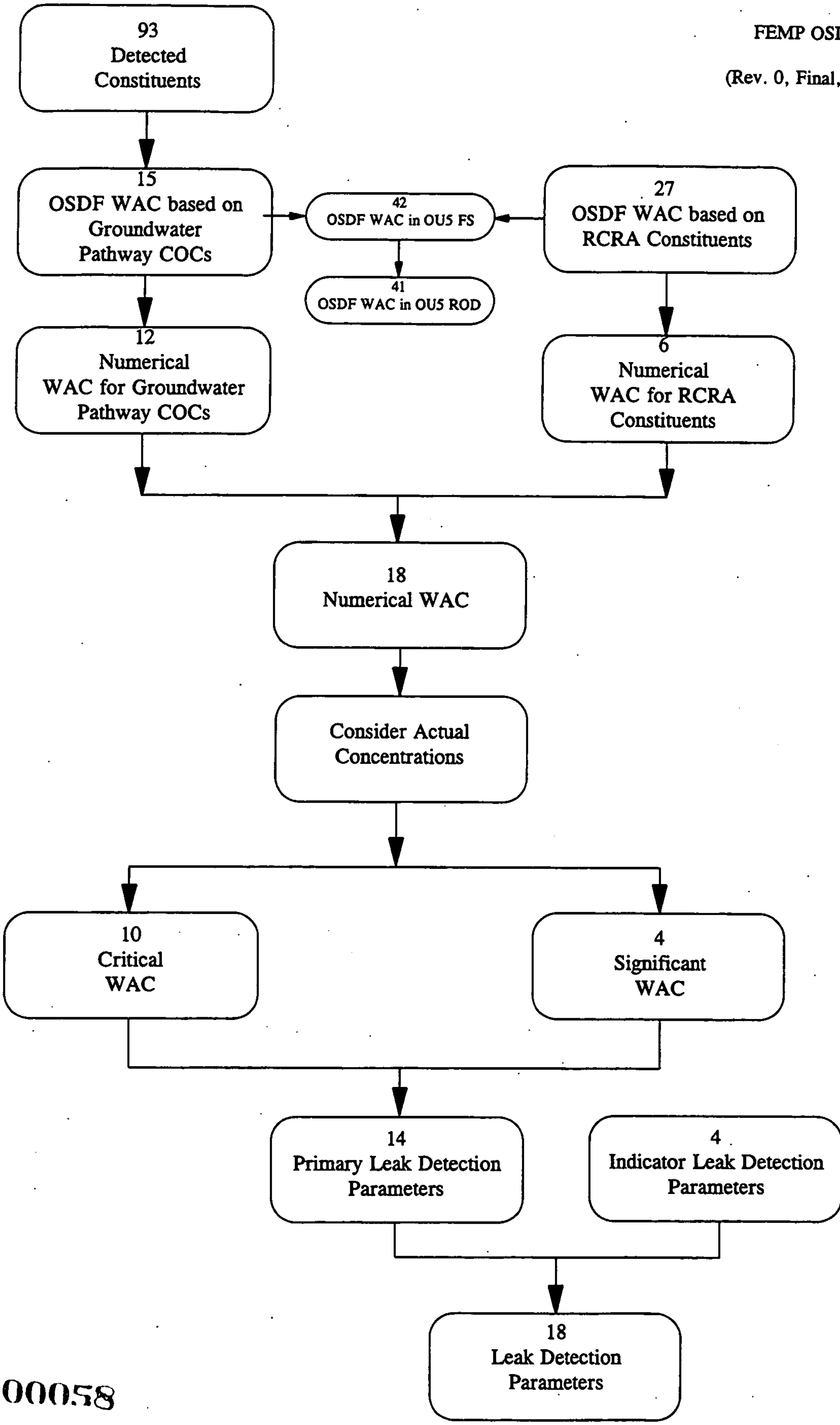

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FIGURE 4-8 - Groundwater/Leak Detection Parameter Selection Process

TABLE 4-2

WAC FOR GROUNDWATER PATHWAY COCS

COC	WAC
Radionuclides: (pCi/g)	
Neptunium-237	3.12×10^{9}
Strontium-90	5.67×10^{10}
Technetium-99	2.91×10^{1}
Total uranium - (mg/kg)	1.03×10^{3}
Organics: (mg/kg)	
Alpha-Chlordane	2.89×10^{0}
Bis(2-chloroisopropyl)ether	2.44×10^{-2}
Bromodichloromethane	9.03×10^{-1}
Carbazole	7.27×10^{4}
1,2-Dichloroethane	*
4-Nitroaniline	4.42×10^{-2}
Vinyl Chloride[1]	1.51×10^{0}
Inorganics: (mg/kg)	
Boron	1.04×10^{3}
Chromium vi[1]	*
Magnesium	*
Mercury[1]	5.66×10^{4}

Notes: *: Denotes constituents that will not exceed designated Great Miami Aquifer action level within 1000-year performance period, regardless of starting concentration in the disposal facility.
1: RCRA constituent.

TABLE 4-3

EXPECTED MAXIMUM COC CONCENTRATIONS IN THE OSDF

COC	Maximum Concentration[1]	WAC	MAX/WAC
Radionuclides: (pCi/g)			
Neptunium-237	2.63×10^{0}	3.12×10^{9}	8.43×10^{-10}
Strontium-90	6.49×10^{0}	5.67×10^{10}	1.14×10^{-10}
Technetium-99	2.91×10^{1}	2.91×10^{1}	**1.00×10^{0}**
Total uranium - (mg/kg)	1.03×10^{3}	1.03×10^{3}	**1.00×10^{0}**
Organics: (mg/kg)			
Alpha-Chlordane	5.10×10^{-3}	2.89×10^{0}	1.76×10^{-3}
Bis(2-chloroisopropyl)ether	2.44×10^{-2}	2.44×10^{-2}	**1.00×10^{0}**
Bromodichloromethane	7.00×10^{-3}	9.03×10^{-1}	7.75×10^{-3}
Carbazole	2.50×10^{-1}	7.27×10^{4}	3.44×10^{-6}
4-Nitroaniline	4.42×10^{-2}	4.42×10^{-2}	**1.00×10^{0}**
Vinyl Chloride[2]	1.51×10^{0}	1.51×10^{0}	**1.00×10^{0}**
Inorganics: (mg/kg)			
Boron	1.43×10^{1}	1.04×10^{3}	1.38×10^{-2}
Mercury	1.30×10^{0}	5.66×10^{4}	2.30×10^{-4}

Notes: 1: Lower value between the WAC and the maximum soil concentration presented in Table F.3.4-3, Operable Unit 5 RI.
2: Also consider Tetrachloroethene and Trichloroethene in soil.

As shown in Table 4-3, the expected maximum soil concentrations in the OSDF reveal that only 5 of the 12 groundwater pathway COCs with numerical WAC (technetium-99, total uranium, vinyl chloride, bis(2-chloroisopropyl)ether, and 4-nitroaniline) are expected to approach their respective WAC concentrations. The other 7 COCs will have maximum soil concentrations in the OSDF that are much less than their corresponding WAC. This information regarding overall abundance is also an important consideration for selecting indicator parameters for the leak detection monitoring program.

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4.5.2.1.2 RCRA Constituents

After the WAC for the groundwater pathway COCs were developed, WAC for 27 additional RCRA-regulated constituents (termed the RCRA COCs) were evaluated. Development of WAC for these specific constituents was considered necessary from a regulatory standpoint to address a requirement that the RCRA COCs not be eliminated in any COC screening step during the RI/FS process. The intention was to demonstrate compliance with RCRA regulations by providing a mechanism for keeping track of the fate of materials contaminated with RCRA constituents during the remediation.

Most of the RCRA COCs are not groundwater pathway COCs and thus the calculated WAC for the majority of these constituents are relatively high (i.e., essentially pure product concentration). Only six of the additional constituents were determined to need a numerical WAC. The details of the RCRA constituent WAC development process is provided in Attachment F.5.I of the Operable Unit 5 FS. Table 4-4 summarizes the results.

The six additional numerical WAC in Table 4-4 are actually not expected to affect any disposal decisions for contaminated waste, soil, and debris from Operable Units 2, 3, and 5. As shown in Table 4-4, the WAC for chloroethane and toxaphene are close to pure product concentration (i.e., 1.00×10^6 mg/kg). The WAC for tetrachloroethene, trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethene are higher than the highest detected soil concentrations which were used in the previous screening process summarized in Table F.2-2 of the Operable Unit 5 FS. The maximum detected soil concentrations presented in Table F.3.4-3 of the Operable Unit 5 RI for tetrachloroethene, trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethene are 1.6×10^0, 8.90×10^1, 3.90×10^{-2}, and 3.4×10^{-1} mg/kg, respectively.

In general, the original 15 groundwater pathway COCs listed in Table 4-2 already include all the constituents detected in soil and groundwater at the FEMP which may have potential to impact the Great Miami Aquifer and, therefore, are more likely to be detectable in the monitoring system in case of a leak from the OSDF.

4.5.2.1.3 Selected Primary Parameters

Based on information presented in Tables 4-2 through 4-4, 14 constituents are selected to be included in the initial primary parameters list for OSDF leak detection monitoring purposes. Table 4-5 summarizes these constituents and the rationale for their selection. Table 4-5 also indicates whether each of the 14 constituents is listed in OAC 3745-27-10 Appendix I as a regulatory default parameter.

TABLE 4-4

WAC FOR ADDITIONAL RCRA CONSTITUENTS

RCRA Constituents	Detected and Previously Screened	WAC	OAC 3745-27-10 Appendix I
Organics: (mg/kg)			
Acetone	yes	*	Yes
Benzene	yes	*	Yes
Carbon tetrachloride	yes	*	Yes
Chloroethane	no	3.92×10^5	Yes
Chloroform	yes	*	Yes
Chloromethane	no	*	Yes
1,1-Dichloroethane	yes	*	Yes
1,1-Dichloroethene	yes	1.14×10^1	Yes
1,2-Dichloroethene	no	1.14×10^1	Yes
Endrin	no	*	No
Ethylbenzene	yes	*	Yes
Heptachlor	no	*	No
Heptachlor epoxide	no	*	No
Hexachlorobutadiene	no	*	No
Methoxychlor	no	*	No
Methylene chloride	yes	*	Yes
Methyl ethyl ketone	yes	*	Yes
Methyl isobutyl ketone	no	*	Yes
Tetrachloroethene	yes	1.28×10^2	Yes
1,1,1-Trichloroethane	yes	*	Yes
Trichloroethene	yes	1.28×10^2	Yes
Toluene	yes	*	Yes
Toxaphene	no	1.06×10^5	No
Xylenes	yes	*	Yes
Inorganics: (mg/kg)			
Barium	yes	*	Yes
Lead	yes	*	Yes
Silver	yes	*	Yes

Note: * : Denotes constituents that will not exceed designated Great Miami Aquifer action level within 1000-year performance period, regardless of starting concentration in the disposal facility.

TABLE 4-5

PROPOSED PRIMARY PARAMETERS LIST

Constituents of Concern	Rationale	Appendix I
Radionuclides: (pCi/g)		
Technetium-99	likely detectable when released	No
Total uranium - (mg/kg)	likely detectable when released	No
Organics: (mg/kg)		
Alpha-Chlordane	likely detectable when released	No
Bis(2-chloroisopropyl)ether	likely detectable when released	No
Bromodichloromethane	likely detectable when released	Yes
Carbazole	likely detectable when released	No
1,1-Dichloroethene	significant RCRA constituent	Yes
1,2-Dichloroethene	significant RCRA constituent	Yes
4-Nitroaniline	likely detectable when released	No
Tetrachloroethene	significant RCRA constituent	Yes
Trichloroethene	significant RCRA constituent	Yes
Vinyl Chloride	likely detectable when released and significant RCRA constituent	Yes
Inorganics: (mg/kg)		
Boron	likely detectable when released	No
Mercury	likely detectable when released and significant RCRA constituent	No

Four (4) of the 18 constituents which have numerical WAC listed in Tables 4-2 or 4-4 (i.e., chloroethane, toxaphene, neptunium-237, and strontium-90) are not selected because of their expected actual maximum concentrations in the OSDF and their comparatively high WAC values which indicate less likely potential impacts and detectability in case of a leak from the OSDF. However, four RCRA constituents which are not groundwater pathway COCs (i.e., tetrachloroethene, trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethene) are selected since their expected maximum soil concentrations are reasonably close to the WAC.

The 14 constituents (i.e., 12 from the groundwater pathway COCs and four from the RCRA constituents) that are selected as the primary leak detection monitoring parameters have a potential of entering the environment in measurable quantities and are likely to be more differentiable from background conditions. These 14 constituents will provide a reliable indication of potential releases from the OSDF to the groundwater.

4.5.2.2 Supplemental Indicator Parameters

In addition to the primary parameters discussed in the preceding subsection, four general groundwater contamination indicator parameters are also proposed to supplement the selected chemical constituents in the initial leak detection monitoring parameters list. These supplemental indicator parameters are comprised of the following:

- pH;
- Specific Conductance;
- Total Organic Halogens (TOX); and
- Total Organic Carbon (TOC).

These general groundwater contamination indicator parameters are typically used to aid in the detection of releases from disposal facilities. These supplemental indicator parameters will provide an added means to detect contaminant migration, and will be useful as indicators for general groundwater quality degradation.

4.5.3 Future Considerations

As mentioned earlier, parameters selected in the initial baseline sampling and analysis approach of the OSDF long-term groundwater monitoring program are intended for establishing the baseline conditions for perched groundwater and the Great Miami Aquifer under the individual cells of the OSDF (i.e., up to 12 monitoring events prior to waste placement). Two subsequent future re-evaluations of the program (e.g., a review of monitoring results accompanying final capping and immediately after completion of aquifer remediation as described in Section 4.4) are envisioned before the long-term post-closure leak detection monitoring parameters list is ultimately finalized. Any modifications resulting from these two re-evaluations will be documented via future amendments to this plan.

Although the currently selected initial indicator parameters will likely provide sufficient and reliable indications of potential releases throughout the operational life of the OSDF, efficiency of the parameters list may still be improved based on the collected data obtained over the course of the program. Any proposed modifications based on the accumulated data base will involve EPA and OEPA review and approval before adoption.

4.5.3.1 Eliminating Monitoring Parameters

An indicator parameter will be considered for elimination from the current program (or the long-term leak detection monitoring parameters list) when the initial pre-waste disposal baseline data indicate significant fluctuations and/or very high concentrations in perched groundwater or Great Miami Aquifer monitoring wells. When the baseline concentrations of a constituent are high, a leak from the OSDF may not be noticeable from monitoring results due to background interferences (i.e., false negative). When the background concentrations fluctuate significantly, there will be a high chance of a false positive of a leak. In either case the constituent cannot be considered a reliable indicator for leak detection purposes.

An indicator parameter will also be considered for elimination from the long-term leak detection monitoring parameters list, if it is not detected in the LCS leachate samples collected during active waste placement. Any constituents not detected in the LCS leachate samples after waste placement are likely to be absent, insoluble, or of insignificant abundance in the OSDF. Therefore, it may not be necessary to analyze these constituents further for leak detection purposes, and a proposal for EPA and OEPA approval of their elimination will be developed.

4.5.3.2 Adding Monitoring Parameters

Based on the analytical results of the annual grab sample of leachate collected in LCS for the parameters specified in Appendix I of OAC 3745-27-10 (see Section 5.0 for more details), detected Appendix I constituents will be evaluated to determine whether the original indicator parameters list is sufficient for leak detection purposes. As mentioned before, most of the Appendix I constituents have already been detected in perched groundwater under the FEMP and were considered when selecting the initial leak detection indicator parameters. It is expected that these constituents will also be detected in future OSDF leachate samples. However, they will not necessarily be adequate indicators of a release. Therefore, Appendix I constituents detected in the annual OSDF LCS samples will not be automatically added to the leak detection indicator parameters list, unless it meets the criteria discussed below.

A new indicator parameter will only need to be considered for addition when its detected concentrations in the annual OSDF LCS samples are much higher than the concentrations that exist currently in the contaminated media underlying the facility (which were evaluated during the initial parameter selection process). An indicator parameter will be added when it can be demonstrated under the considerations provided in Section 4.5.1 that routine analysis of the constituent in the leak detection monitoring system can significantly enhance the early detection capability of the monitoring program. Evaluations of the annual leachate grab sampling data will be conducted to determine the need for adjustments to the current parameter list; the results of the evaluations will be reported in accordance with the OAC 3745-27-19(M) reporting requirement.

4.6 Leak Evaluation Strategy

The leak evaluation strategy for each OSDF cell is two-fold:

- trend analysis for the LCS, LDS, the glacial till, and the Great Miami Aquifer will help pinpoint potential leak-related influences within each leak detection program element; and
- the monitoring results from all elements will be correlated and evaluated holistically to determine whether a release has occurred and if a response action is necessary.

These components are discussed in the next two sections.

4.6.1 Trend Analysis

The initial flow and water quality data obtained from the LCS, LDS, and the groundwater monitoring components will be used to begin a qualitative trend analysis of the volume of leachate produced by each cell and the corresponding concentrations of analytes in each individual monitoring component. Each cell will be evaluated independently; consequently, an "intra-well" trend analysis will be used. As part of the establishment of baseline conditions, an identification of an appropriate statistical method for the trend analysis will be made following the receipt and review of all baseline data. The identified method will be presented to EPA and OEPA for approval at the conclusion of the baseline activity. The type of statistical method will be selected after sufficient sampling events have been completed for each baseline, and will be incorporated as an amendment to this plan following EPA and OEPA approval.

The intra-well trend analysis approach can be applied to data from all the elements — the LCS, LDS, and the groundwater monitoring components. The approach will be most advantageous, however, for groundwater given the inherent difficulties in distinguishing potential releases from the OSDF from existing above-background levels of monitoring constituents in the area of the OSDF, and the expected change in groundwater flow directions that will result from aquifer restoration activities.

After the remediation of the Great Miami Aquifer is complete and groundwater flow directions return to pre-restoration conditions, an inter-well upgradient to downgradient comparison of the groundwater data will be initiated for the Great Miami Aquifer wells. Additionally, the point by point intra-well trending comparisons will continue for each of the Great Miami Aquifer wells and for the perched water obtained from each cell's till monitoring point.

As indicated above in Section 4.4.2.1, "action leakage rate(s)" for the LDS are to be developed later via trend analysis of LDS flow monitoring on closed cells prior to closure of the last cell of the OSDF. The "pump operating level" for the LTS permanent lift station sump also is to be developed later, based upon measurements after the final cover has been placed over the last cell of the OSDF. It is anticipated that this will be established via trend analysis on LCS flow monitoring measurements prior to and after closure of the last cell of the OSDF.

4.6.2 Correlation of Monitoring Data

If liquid is collected from the LDS, it does not necessarily mean that the OSDF's leachate is leaking through the primary liner into the LDS. Liquid in the LDS could be from sources other than from within a particular cell. To determine whether liquid in the LDS is leachate and the primary liner of a cell is leaking, a correlation must exist between the LCS and LDS analyte concentrations; a correlation must also exist between the increases in volume of liquid in the LCS and the LDS ("flow monitoring data"). If volume increases and analyte concentrations between the two systems correlate, then a leak through the primary composite liner system will be suspected. The significance of the suspected leak to the protection of the environment depends upon the concentrations of the analytes found in the LDS and the volume of liquid present. Analyte concentrations and volume versus time plots of groundwater collected from the till monitoring wells will be correlated with LCS and LDS data to detect a leak in the secondary composite liner system that contains the three-foot compacted clay liner.

The primary purpose for the data collected in the Great Miami Aquifer is to establish a baseline from which to determine if leakage from the OSDF is detrimentally affecting the Great Miami Aquifer. It is recognized that an exhaustive characterization of the Great Miami Aquifer has already been conducted from which to determine FEMP impacts (from sources other than the OSDF) and establish FEMP-specific constituents of concern and associated final remediation levels. From this, a protective remedy for the Great Miami Aquifer has been developed, the success of which will be tracked through IEMP monitoring of site specific indicator constituents. This has been documented in the Operable Unit 5 RI and FS Reports, the Operable Unit 5 Record of Decision, and the draft IEMP (DOE, 1997).

A secondary purpose for the Great Miami Aquifer data collected through the OSDF monitoring plan is to supplement the IEMP remedy performance monitoring data that will be collected for the aquifer. Groundwater data for those OSDF leak detection constituents that are also common to the IEMP groundwater remedy performance constituents will be utilized in the IEMP data interpretations as the data become available. Groundwater data collected for those unique OSDF leak detection constituents which are not being monitored by the IEMP groundwater monitoring program will be utilized only for the establishment of the OSDF baseline and subsequent leak detection monitoring.

5.0 LEACHATE MANAGEMENT MONITORING PROGRAM

As discussed in Section 3.0, the Ohio Solid Waste Disposal regulations require the preparation of a leachate management monitoring plan to support the overall leak detection strategy and comply with the leachate management and monitoring requirements in OAC 3745-27-19(M)(4) and (5). To fulfill these requirements, the leachate management monitoring plan needs to provide:

1. a means to track the quantity of leachate collected for treatment and discharge, reported on a monthly basis;

2. a means to verify that the engineering components of the leachate management system will operate in accordance with OAC 3745-27-19, Operational Criteria for a Sanitary Landfill Facility;

3. a description of the site-specific leachate treatment and discharge elements, to ensure that the leachate collected from the facility is properly managed; and

4. collection and analysis of an annual leachate grab sample for parameters listed in Appendix I of OAC 3745-27-10 to confirm, on an ongoing basis, the adequacy and appropriateness of the selected leak detection monitoring parameters.

Item 1 of the above requirements is fulfilled by the flow monitoring component of the leak detection monitoring strategy. Flow measurements will take place at least monthly during active cell operations for both the LCS and LDS drainage layers (see Section 4.4.2). Item 2 of the above requirements is fulfilled by Section 3.0 of the OSDF Systems Plan, which describes the operation and maintenance activities for the OSDF's leachate management system to be employed during active cell operations. The OSDF Systems Plan was first submitted to EPA and OEPA as part of the OSDF Intermediate (60%) Design Package (GeoSyntec, 1996b).

The remaining two items (items 3 and 4) are described in Sections 5.1 and 5.2 respectively.

5.1 Monitoring to Support Leachate Treatment and Discharge

All leachate from the OSDF will be treated within the FEMP's on-site AWWT facility prior to discharge at a National Pollutant Discharge Elimination System (NPDES)-permitted outfall to the Great Miami River. Below is a description of the management approach for leachate treatment within the AWWT facility, along with a description of the treatment system and the leachate monitoring needs to ensure proper operation of the AWWT facility and compliance with the NPDES Permit.

5.1.1 Management Approach

All leachate collected through the OSDF's LCS and LDS drainage layers will be routed to Phase 2 of the AWWT facility for treatment. Phase 2 is a part the AWWT facility which was constructed to treat a variety of sitewide process water, stormwater, and remediation wastewater generated during the FEMP's remedial actions. AWWT Phase 2 includes treatment processes for a broad spectrum of contaminants and includes alum flocculation, clarification, filtration, carbon adsorption, and ion exchange.

Leachate will be collected from both the LCS and LDS layers of each cell of the OSDF, whenever such fluids are present. The leachate that accumulates in each layer will flow by gravity for removal via a lift station at the southwestern edge of each cell, as illustrated in the OSDF Final Design Package (GeoSyntec 1996a). After reaching the lift station, the leachate is then pumped to the surge lagoon, which is the primary collection point for remedial wastewater to be delivered to the AWWT Phase 2 facility. The surge lagoon also collects other process and remediation wastewaters, prior to feeding into the AWWT facility. All AWWT facility treated wastewaters are discharged at an NPDES-permitted outfall to the Great Miami River.

5.1.2 Monitoring Needs

To ensure that the FEMP's NPDES permit conditions associated with the effluent from the AWWT facility are met, and to ensure that introduction of the leachate as a wastestream does not interrupt or affect the proper operation of the AWWT facility, select analytical parameters for the leachate will be monitored after leachate collection and prior to treatment. The volume of leachate, as determined from the flow rate monitoring described in Section 4.4.2, will be recorded and the information provided to the appropriate personnel (AWWT facility operators), along with data on the select parameters.

As stated, OSDF leachate is delivered to the surge lagoon prior to treatment through AWWT Phase 2. Therefore, any significant levels of contaminants within the OSDF leachate will quickly be equalized in the surge lagoon mitigating any potential spikes of contaminant concentration or flow. However, four parameters require analysis to ensure that the leachate does not detrimentally affect the treatment system -- pH, TOC, nitrate/nitrite, and total dissolved solids (TDS).

Analysis for pH and TOC are already planned to be conducted quarterly for the leachate as part of the supplemental indicator parameters for the groundwater/leak detection monitoring program described in Section 4.0. The other two parameters, nitrate/nitrite and TDS, will be monitored as part of this leachate management monitoring plan. Nitrate/nitrite is an important parameter to ensure that

State of Ohio Water Quality Criteria are met in the Great Miami River, due to the AWWT facility effluent discharge. Knowledge of TDS concentrations is required to ensure proper operation during removal of metals. Wastewaters high in TDS will also be mixed with other wastewaters, if necessary, to ensure proper operation of the AWWT system.

Any other parameters that are expected in the OSDF leachate are not likely to be present at concentrations that are detrimental to the system operations. An NPDES Permit Renewal Application is being prepared which will address the OSDF leachate. No adverse impacts on future effluent limitations are anticipated as a result of OSDF leachate.

Nitrate/nitrite and TDS concentrations will be analyzed quarterly on recovered leachate fluids to ensure that seasonal changes (if any) in concentrations are accounted for over the course of the year. This frequency is considered adequate for this initial version of the leachate management monitoring plan. In the event that more frequent sampling is found to be necessary to support AWWT operations, a modification will be submitted as an amendment to this plan.

5.2 Confirmation of Leak Detection Parameters

The final leachate management monitoring requirement entails the annual confirmation of the site-specific leak detection monitoring parameter list, discussed in Section 3.2.1.3 and 4.5. The purpose of this annual sampling is to confirm the appropriateness of the site-specific leak detection monitoring parameters in the event that leachate composition changes over time, as described in Proposed OEPA Policy DDAGW-04-03-221. An annual leachate grab sample will be obtained and analyzed for parameters listed in Appendix I of Ohio Solid Waste regulation OAC 3745-27-10. This sampling is necessary to fulfill the reporting requirement in OAC 3745-27-19(M)(5), which requires the reporting of data from an annual grab sample of leachate for all Appendix I constituents.

While it is anticipated that the results from analysis of the annual grab of leachate may indicate the presence of parameters not included in the leak detection monitoring parameter list, it is not anticipated that these other parameters would exist in the leachate at concentrations high enough to warrant their addition to the leak detection parameter list. However, the criteria for adding additional parameters to the program, should they be necessary as a result of the grab sample results, is discussed in Section 4.5.3.

5.3 Future Considerations

The leachate management monitoring program described above is designed for OSDF leachate conditions during the active operations of the facility. Once the OSDF cap has been installed, and the facility is under post-closure care and monitoring, the leachate management monitoring needs may change. For instance, less leachate will be generated after the cap installation, however, the leachate contaminant concentrations may be increased. Such changes in the leachate characteristics and volume may affect the monitoring needs to ensure proper management of the leachate.

Additionally, the frequency for sampling leachate for parameters necessary to determine proper management within the AWWT facility may be increased, if necessary. Section 6.0 provides further information concerning the process for altering any of the components of this plan.

6.0 REPORTING

6.1 Routine Reporting Responsibilities

The construction, filling, closure, and attendant inspection and maintenance of the OSDF is an OSDF Project Group activity, and the physical monitoring of the LCS, LDS, glacial till, and Great Miami Aquifer will also be the responsibility of the OSDF Project Group.

Construction of the northern-most cell of the OSDF and associated monitoring will begin in 1997. The first glacial till monitoring well will be installed during the initial phase of construction of the northern-most OSDF cell. Monitoring of the glacial till well will begin during construction and before waste placement. Additional glacial till monitoring wells will be installed as the other OSDF cells are constructed.

As indicated in Section 4.4, after the baseline sampling events are completed, DOE will evaluate whether sufficient data are available to ascertain the type of distribution of the data, and from that select an appropriate statistical method and associated statistical measure. This determination is anticipated to be made on a parameter-, monitoring-point-, system- (*i.e.*, glacial till, and Great Miami Aquifer), and cell-specific basis. Also, once sufficient samples are in hand to establish a baseline for a sampling point, the leak detection program sampling frequency for that point will be reduced to quarterly. These cell-specific evaluations are anticipated to be summarized in cell-specific technical memoranda, which will be submitted to EPA and OEPA for review. The technical memoranda will serve as the mechanism to propose modifications to this initial groundwater/leak detection and leachate monitoring plan, in areas such as but not limited to the following:

- modification of sampling frequency for LCS, LDS, glacial till, or Great Miami Aquifer monitoring points, based upon considerations presented in Section 4.4.3
- modification of leak detection monitoring parameters list for routine monitoring based upon considerations presented in Section 4.5.3
- modification of leachate management monitoring parameters based upon considerations presented in Section 5.3
- establishment of parameters list for statistical analysis
- establishment of frequency for statistical analysis
- establishment of appropriate statistical method and associated statistical measurements
- establishment of "action leakage rate" for the LDS

- establishment of "pump operating level" for the LCS
- temporary suspension, or cessation, of sampling and attendant statistical analysis for monitoring points (either singly or in combination)
- modifications to address future needs resulting from the completion of aquifer restoration and/or the entry of the OSDF into the post-closure care mode.

Where appropriate, the approved the technical memoranda will be attached as addenda to this plan, formally resulting in an amended groundwater/leak detection and leachate monitoring plan.

To provide an integrated approach to reporting OSDF monitoring data, the annual IEMP comprehensive annual environmental report will serve as the mechanism by which the OSDF Project Group will report LCS and LDS volumes and concentrations, along with groundwater monitoring results, trending results, and interpretation of the data. Presenting data in one report will facilitate a qualitative assessment of the impact of the OSDF on the aquifer, as well as the operational characteristics of OSDF caps and liners. Additionally, the available monitoring data and interpretation of that data will be made available quarterly as part of the IEMP reporting process.

6.2 Notifications and Response Actions

If the flow rate into the LDS exceeds the "action leakage rate" (see Section 4.4.2.1) for any LDS sump, the actions presented in Table 6-1 will be implemented. Note that some of these response actions — i.e., those that do not pose an immediate and substantial threat to human health or the environment — might best be served by a corrective action (see Section 10.0 of the OSDF Post-Closure Care and Inspection Plan [FERMCO, 1996]).

If it is determined that both the cap and primary liner have failed, then an OSDF response action will be required. A response action might include initiating cap repair, investigating whether or not contamination has breached the compacted clay liner component of the secondary composite liner system that lies beneath the LDS, or increasing Great Miami Aquifer monitoring, or a combination of these. Potential leakage through the clay liner will be assessed by using the till well installed beneath the sump area and secondary liner; however, till well monitoring cannot be considered all conclusive for detecting a leak. Comparison of the data from all four systems is needed to determine if a leak has occurred. If it is determined that a leak has adversely impacted the groundwater (till and/or Great Miami Aquifer), then a *groundwater quality assessment monitoring program* will be developed and initiated to determine the nature, rate, and extent of contaminant migration.

Table 6-1
NOTIFICATION AND RESPONSE ACTIONS

Step	Timeframe	Action
1	Within 7 days of the determination of the exceedance.	Notify both the following in writing: • EPA Region 5 Regional Administrator 77 West Jackson Boulevard Chicago, Illinois 60604-3590 • Ohio Director of Environmental Protection 1800 Watermark Drive P.O. Box 1049 Columbus, Ohio 43266-0149
2	Within 14 days of the determination of the exceedance.	Submit to both of the individuals identified in Step 1 a written preliminary assessment as to the: • Amount of liquids. • Likely sources of liquids. • Possible location, size, and cause of any leaks. • Short-term actions taken and planned.
3	As practicable to meet Step 7.	Determine to the extent practicable the location, size and cause of any leak.
4	As practicable to meet Step 7.	Determine: • Whether receipt of impacted materials should be ceased or curtailed. • Whether any impacted materials within the OSDF or any individual cell/phase should be removed for inspection, repairs, or controls.
5	As practicable to meet Step 7.	Determine any other short- or long-term actions to take to stop or mitigate the leaks.
6	As practicable to meet Step 7.	In order to conduct Steps 3-5: • Assess the source of liquids, and amounts of liquids by source; and • In order to identify the source of liquids and the possible location of any leaks, and the hazard and mobility of the liquid, conduct a fingerprint, hazardous constituent, or other analyses of the liquids in the LDS; and • Assess the seriousness of any leaks in terms of potential for escaping into the environment. OR • Document why such assessments are not needed.
7	Within 30 days of the notification given in Step 1.	Submit to both of the individuals identified in Step 1 a written report of the: • Results of the analyses & determinations made under Steps 3-6 (to the extent completed). • Results of action taken. • Actions ongoing (*i.e.*, analyses and determinations under Steps 3-6 not yet completed) or planned (see Section 10.0 of the *OSDF Post-Closure Care and Inspection Plan*).
8	Monthly thereafter, as long as the flow rate in the LDS exceeds the action leakage rate.	Submit to both of the individuals identified in Step 1 a written report summarizing the: • Results of actions taken. • Actions planned.

SOURCE: Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N—Landfills, Response Actions, 40 CFR §§264.304(b) and 265.303(b).

Groundwater monitoring might also be increased to determine if leakage from the OSDF has entered the Great Miami Aquifer, although given the distances involved it would be unlikely that leakage from the OSDF would be able to migrate to the Great Miami Aquifer in the short time frame between leak detection and response.

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APPENDIX A

OSDF ARARs AND OTHER REGULATORY REQUIREMENTS

APPENDIX A

OSDF ARARS AND OTHER REGULATORY REQUIREMENTS

ARARs and to be considered criteria (TBCs) — for OSDF groundwater detection monitoring, OSDF leachate monitoring, and OSDF response action — that should be addressed by this plan are provided here, as obtained from the *Final Record of Decision for Remedial Actions at Operable Unit 2 (OU2 ROD)* [DOE, 1995b], the *Record of Decision for Final Remedial Action at Operable Unit 3 (OU3 ROD)* [DOE, 1996d], the *Final Record of Decision for Remedial Actions at Operable Unit 5 (OU5 ROD)* [DOE, 1996b], or the *Permitting Plan and Substantive Requirements for the On-Site Disposal Facility* [DOE, 1996c]. Additional regulatory requirements that are appropriate guidance for formulation of this plan have been also identified and included.

TABLE A-1

OSDF GROUNDWATER/LEAK DETECTION AND LEACHATE MONITORING PLAN COMPLIANCE STRATEGY ARARs AND OTHER REGULATORY REQUIREMENTS

Citation	Requirement
PLANS	
Ohio Municipal Solid Waste Rules—Sanitary Landfill Facility Permit to Install Application OAC 3745-27-06(C)(7)(a) and (c)	• Prepare a "groundwater detection monitoring plan" as required by OAC 3745-27-10, and if applicable a "groundwater quality assessment plan" and/or "corrective measures plan" required by OAC 3745-27-10.
	• Prepare a "leachate monitoring plan" to ensure compliance with OAC 3745-27-19(M)(4).
GROUNDWATER/LEAK DETECTION MONITORING	
Ohio Municipal Solid Waste Rules—Groundwater Monitoring Program for a Sanitary Landfill Facility OAC 3745-27-10(A)	(1) The owner or operator of a sanitary landfill facility shall implement a "groundwater monitoring program" capable of determining the quality of groundwater occurring within the uppermost aquifer system and all significant zones of saturation above the uppermost aquifer system underlying the landfill facility, with the following elements: (a) A "groundwater detection monitoring program" which includes: (i) a "groundwater detection monitoring plan" in accordance with OAC 3745-27-10(B) through (D); (ii) a monitoring system in accordance with OAC 3745-27-10(B); (iii) sampling and analysis procedures, including an appropriate statistical method, in accordance with OAC 3745-27-10(C); and (iv) detection monitoring procedures, including monitoring frequency and a parameter list, in accordance with OAC 3745-27-10(D). (2) Schedule for implementation of detection monitoring. (b) The owner or operator of a sanitary landfill facility shall implement the "groundwater detection monitoring plan" prior to waste receipt. (4) For purposes of this rule, the groundwater monitoring program is implemented upon commencement of sampling of groundwater wells.
Ohio Municipal Solid Waste Rules—Ground Water Monitoring System OAC 3745-27-10(B)	(1) The "groundwater detection monitoring program" shall consist of sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from both the uppermost aquifer system and any significant zones of saturation that exist above the uppermost aquifer system that: (a) represent the quality of the background groundwater that has not been affected by past or present operations; and (b) represent the quality of the groundwater passing directly down gradient of the limits of solid waste placement. (4) The number, spacing, and depth of groundwater monitoring wells shall be: (a) based on site specific hydrogeologic information; and (b) capable of detecting a release from the facility to the groundwater at the closest practicable location to the limits of waste placement.

TABLE A-1 (Continued)

Citation	Requirement
	GROUNDWATER/LEAK DETECTION MONITORING (Cont'd.)
Ohio Municipal Solid Waste Rules— Ground Water Sampling, Analysis, and Statistical Methods OAC 3745-27-10(C)	(1) The "groundwater monitoring program" shall include consistent sampling and analysis procedures and statistical methods that are protective of human health and the environment and that are designed to ensure monitoring results that provide an accurate presentation of groundwater quality at the background and down gradient well. (a) Sampling and analysis procedures employed must be documented in a written plan. (b) The statistical method selected by the owner or operator must be in accordance with OAC 3745-27-10(C)(6)&(7). (6) After completing collection of the background data, the owner or operator shall specify one of the following statistical methods to be used in evaluating groundwater quality; the statistical method chosen must be conducted separately for each of the parameters required to be statistically evaluated: (a) a parametric analysis of variance (ANOVA); or (b) an analysis of variance (ANOVA) based on ranks; or (c) a tolerance or prediction interval procedure; or (d) a control chart approach; or (e) another statistical method. (7) Performance standards for statistical methods. (a) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of chemical parameters or leachate and leachate-derived constituents. If shown to be inappropriate, then the data should be transformed or a distribution free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed. (e) The statistical method shall account for data below the limit of detection with one or more statistical procedures that ensure protection of human health and the environment. Any practical quantitation limit (PQL) used in the statistical method shall be the lowest concentration level that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility. (f) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temperal correlation in the data. (9) The number of samples collected to establish groundwater quality data shall be consistent with the appropriate statistical procedures.

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TABLE A-1 (Continued)

Citation	Requirement
	GROUNDWATER/LEAK DETECTION MONITORING (Cont'd.)
Ohio Municipal Solid Waste Rules—Ground Water Detection Monitoring Program OAC 3745-27-10(D)	(2) Alternate monitoring parameter list. The owner or operator of a sanitary landfill facility may propose to delete any of the Appendix I parameters of this rule. The alternative monitoring parameter list may be approved if the removed parameters are not reasonably expected to be in or derived from the waste contained or deposited in the landfill facility. The following factors should be considered: (a) which of the parameters in Appendix I shall be deleted; (b) types, quantities, and concentrations of constituents in wastes managed at the landfill facility; (c) the concentrations of Appendix I constituents in the leachate from the relevant unit(s) of the landfill facility; (d) any other relevant information. (3) Alternate inorganic parameter list. The owner or operator of a sanitary landfill facility may propose that an alternative list of inorganic indicator parameters to be used in lieu of some or all of the inorganic parameters listed in Appendix I of this rule. The alternative inorganic indicator parameters may be approved if the alternative list will provide a reliable indication of inorganic releases from the facility to the groundwater. The following factors should be considered: (a) the types, quantities, and concentrations of constituents in wastes managed at the facility; (b) the mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the facility; (c) the detectability of the indicator parameters, waste constituents, and their reaction products in the ground water; and (d) the concentrations or values and coefficients of variation of monitoring parameters or constituents in the background groundwater quality. (5) Monitoring parameters, frequency, location. The owner or operator shall monitor the groundwater monitoring well system (a) and (b) during the active life of the facility (including final closure and the post-closure care period, (ii) at least semiannually by collecting: *(a)* during the initial one hundred and eighty days after implementing the groundwater detection monitoring program (the first semiannual sampling event), a minimum of four independent samples from each monitoring well. *(b)* during subsequent semiannual sampling events, at least one sample for each monitoring well. (iii) beginning with receiving the results from the second semiannual monitoring event and semiannually thereafter, by statistically analyzing the results. (6) Alternative sampling and statistical analysis frequency. The owner or operator of a sanitary landfill facility may propose an alternative frequency for groundwater sampling and/or statistical analysis. The alternative frequency may be approved provided it is not less than annual. The following factors should be considered: (a) lithology of the aquifer system and all stratigraphic units above the uppermost aquifer system; (b) hydraulic conductivity of the uppermost aquifer system and all stratigraphic units above the uppermost aquifer system; (c) groundwater flow rates for the uppermost aquifer system and all zones of saturation above the uppermost aquifer system; (d) minimum distance between the upgradient edge of the limits of waste placement of the landfill facility and the downgradient monitoring well system; and (e) resource value of the uppermost aquifer system. **NOTE:** Table B-3 of the OU5 ROD @ p. B.3-25 states "an alternate list of monitoring parameters will be required".

TABLE A-1 (Continued)

Citation	Requirement
GROUNDWATER/LEAK DETECTION MONITORING (Cont'd.)	
Ohio Hazardous Waste General Facility Standards-New Facilities Rules-Required Programs OAC 3745-54-91; 40 CFR 264.91	Owners or operators subject to the groundwater protection rules must conduct a monitoring and response program as follows: (1) whenever hazardous constituents from a regulated unit are detected at the compliance point, the owner or operator must institute a compliance monitoring program. "Detected" is defined as statistically significant evidence of contamination. (2) whenever the groundwater protection standard is exceeded, the owner or operator must institute a corrective action program. "Exceeded" is defined as statistically significant evidence of increased contamination. (3) whenever hazardous constituents from a regulated unit exceed concentration limits in groundwater between the compliance point and the downgradient facility property boundary, the owner or operator must institute a corrective action program. (4) in all other cases, the owner or operator must institute a detection monitoring program.
Ohio Hazardous Waste General Facility Standards-New Facilities Rules-Groundwater Protection Standard OAC 3745-54-92; 40 CFR 264.92	The owner or operator must comply with conditions specified in the facility permit that are designed to ensure that hazardous constituents detected in the groundwater from a regulated unit do not exceed the specified concentration limits (specified in the permit) in the uppermost aquifer underlying the waste management area beyond the point of compliance. The groundwater protection standard will be established when hazardous constituents have been detected in the groundwater.
Ohio Hazardous Waste General Facility Standards-New Facilities Rules-Hazardous Constituents OAC 3745-54-93; 40 CFR 264.93	(A) The permit will specify the hazardous constituents to which the groundwater protection standard applies. Hazardous constituents are those that have been detected in the groundwater in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless excluded under paragraph B of this rule. (B) A constituent will be excluded from the list of hazardous constituents specified in the facility permit if it is found that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. The following will be considered: (1) Potential adverse effects on groundwater quality, considering: (a) the physical and chemical characteristics of the waste in the regulated unit, included its potential for migration; (b) the hydrogeological characteristics of the facility and surrounding land; (c) the quantity of groundwater and the direction of groundwater flow; (d) the proximity and withdrawal rates of groundwater users; (e) the current and future use of groundwater in the area; (f) the existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality; (g) the potential for health risks caused by human exposure to waste constituents; (h) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; (i) the persistence and permanence of the potential adverse effects.
Ohio Hazardous Waste General Facility Standards-New Facilities Rules—General Groundwater Monitoring Requirements OAC 3745-54-97; 40 CFR 264.97	(G) In detection monitoring or where appropriate in compliance monitoring, data on each constituent specified in the permit [or in the monitoring plan] is to be collected from background wells and wells at compliance point(s). The number and kinds of samples collected to establish background shall be appropriate for the form of statistical test employed. The sample size should be as large as necessary to ensure with reasonable confidence that a contaminant release to the groundwater from a facility will be detected. The owner or operator will determine an appropriate sampling procedure and interval for each constituent. (H) The owner or operator is to specify one of the following statistical methods to be used in evaluating groundwater monitoring data for each constituent to be specified ... Use of any of the following statistical methods must be protective of human health and the environment: (1) a parametric analysis of variance (ANOVA); (2) an analysis of variance (ANOVA) based on ranks; (3) a tolerance or prediction interval procedure; (4) a control chart approach; or (5) another statistical method.

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TABLE A-1 (Continued)

Citation	Requirement
	GROUNDWATER/LEAK DETECTION MONITORING (Cont'd.)
Ohio Hazardous Waste General Facility Standards-New Facilities Rules—Detection Monitoring Program OAC 3745-54-98; 40 CFR 264.98	(A) The owner or operator must monitor for indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in groundwater. The director [of OEPA] will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors: (1) types, quantities, and concentrations of constituents to be managed at the regulated unit; (2) mobility, stability, and persistence of the waste constituents or their reaction products in the unsaturated zone beneath the waste management area; (3) detectability of the indicator parameters, waste constituents, and their reaction products in the ground water; and (4) concentrations or values and coefficients of variation of proposed monitoring parameters or constituents in the ground water background. (D) The permit will specify the frequencies for collecting samples and conducting statistical tests to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent specified in the permit. (F) The owner or operator must determine whether there is statistically significant evidence of contamination for any chemical parameter or hazardous constituent specified in the permit at the frequency specified in the permit.
Federal Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings: Subpart D—Standards for Management of Uranium Byproduct Material Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended 40 CFR §192.30 through .34	Uranium byproduct materials shall be managed to conform to the ground water protection standard in 40 CFR §264.92, which includes detection monitoring. Alternate concentration limits for uranium can be established, as described in 40 CFR §264.95 and §264.94(b).
Environmental Monitoring DOE Order 5820.2A, Chapter III(3)(k)	Each non-operational low-level waste disposal facility shall be monitored by an environmental monitoring program that, at a minimum, meets the requirements listed below: • Based on the characteristics of the facility monitored, the environmental monitoring program may include, but not necessarily be limited to, monitoring subsurface water, both in the saturated and unsaturated zones. • The monitoring program shall be capable of detecting changes in trends in performance far enough in advance to allow application of necessary corrective action before exceeding performance objectives. The monitoring program shall be able to ascertain whether or not effluents from each treatment or disposal facility or disposal site meets the requirements of applicable DOE Orders.
	LEACHATE MANAGEMENT & MONITORING
Ohio Municipal Solid Waste Rules—Operational Criteria for a Sanitary Landfill Facility OAC 3745-27-19(M)(4)&(5)	The owner annually shall report: • a summary of the quantity of leachate collected for treatment and disposal on a monthly basis during the year; location of leachate treatment and/or disposal; and verification that the leachate management system is operating in accordance with this rule; • results of analytical testing of an annual grab sample of leachate.
	OTHER REQUIREMENTS
Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N—Landfills, Monitoring and Inspection 40 CFR §264.302	Action Leakage Rate: (a) The action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system overburden pressures, etc.). (b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under 40 CFR §264.303(c), to an average daily flow rate (gallons per acre per day) for each sump. Unless the [EPA] approves a different calculation, the average daily flow rate for each sump must be calculated weekly during the active life and closure period, and monthly during the post-closure care period when monthly monitoring is required under 40 CFR §264.303(c).

TABLE A-1 (Continued)

Citation	Requirement
OTHER REQUIREMENTS (Cont'd.)	
Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N—Landfills, Monitoring and Inspection 40 CFR §264.303(c)	An owner or operator required to have a leak detection system must record the amount of liquids removed from each leak detection system sump as follows: (1) During the active life and closure period, at least once each week. (2) After the final cover is installed, in accordance with the following graded approach — • at least monthly; or • if the liquid level in the sump stays below the pump operating level for two consecutive months, at least quarterly; or • if the liquid level in the sump stays below the pump operating level for two consecutive quarters, at least semi-annually; but • if at any time during the post-closure care period the pump operating level is exceeded at units on quarterly or semi-annual recording schedules, the owner or operator must return to monthly recording of amounts of liquids removed from each sump until the liquid level again stays below the pump operating level for two consecutive months. **NOTE:** There are no requirements in Ohio hazardous waste or Ohio solid waste rules regarding leak detection system flow monitoring.
Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N—Landfills, Response Actions 40 CFR §264.304	(a) The owner or operator of landfill units ... must have an approved "response action plan" before receipt of waste. The response action plan must set forth the action to be taken if the "action leakage rate" has been exceeded [in any leak detection system sump]. (b) At a minimum, the response action plan [see entry 2 above] must describe the following actions to be taken: (1) Notify the Regional Administrator in writing of the exceedance within 7 days of the determination; (2) Submit a preliminary written assessment to the Regional Administrator within 14 days of the determination, as to the amount of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short-term actions taken and planned; (3) Determine to the extent practicable the location, size, and cause of any leak; (4) Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed; (5) Determine any other short-term or longer-term actions to be taken to mitigate or stop any leaks; and (6) Within 30 days of the notification that the action leakage rate has been exceeded, submit to the Regional Administrator the results of the analysis specified in (3), (4) and (5) [above], the results of action taken, and actions planned. Monthly thereafter, as long as the flow rate in the leak detection system exceeds the action leakage rate, the owner or operator must submit to the Regional Administrator a report summarizing the results of any remedial actions taken and actions planned. (c) To make the leak and/or remedial action determinations in paragraphs (b)(3), (4) and (5) [above], the owner or operator must: • Asses the source of liquids, and amount of liquids by source; • Conduct a fingerprint, hazardous constituent, or other analyses of the liquids in the leak detection system to identify the source of liquids and possible location of any leaks, and the hazard and mobility of the liquid; and • Assess the seriousness of any leaks in terms of potential for escape to the environment; or • Document why such assessments are not needed.

APPENDIX B

SAMPLING AND ANALYSIS REQUIREMENTS

B.0 SAMPLING AND ANALYSIS REQUIREMENTS

NOTE 1:	Prior to sampling, refer to the addenda to this plan; they are anticipated to override both the frequency(ies) for sampling and the monitoring parameters list(s).

NOTE 2:	If a conflict exists between the specifics in this section (or corresponding sections in subsequent addenda) and Standard Operating Procedure SC-GM-FO-201, the specifics of this section (or corresponding sections in future addenda) govern.

B.1 Sampling Requirements

For the OSDF *groundwater/leak detection monitoring program* for the LCS, LDS, glacial till and Great Miami Aquifer monitoring points, Section 4.0 governs the general strategy including sampling frequency, while Table B-1 summarizes the sampling procedures and analysis requirements, for the *initial baseline period*. Both the frequency for sampling and the monitoring parameters list are anticipated to be overridden by future addenda to this plan.

For OSDF *leachate management monitoring program* monitoring, Section 5.0 governs the general strategy including sampling frequency, while Table B-2 governs the sampling procedures and analysis requirements. Both the frequency for sampling and the monitoring parameters list might be overridden by future addenda to this plan.

NOTE 3:	Field measurement of certain parameters are required; see General Chemistry in Table B-1 and Field Parameters in Table B-2 (or corresponding tables in future addenda).

Prior to sampling, the liquid volume in each monitoring point shall be estimated and recorded on the Water Sample Collection Log by the water monitoring sampling technicians. For the Great Miami Aquifer monitoring points, this consists of measuring the water level in accordance with Standard Operating Procedure SC-GM-FO-201, "Groundwater Sampling Activities." For the glacial till monitoring points and the LDS monitoring points, this consists of a similar measurement of liquid levels. This measured height of liquid column will then be used with the inner diameter of the pipe to estimate the liquid volume.

NOTE 4:	Do not purge the LCS, LDS, and glacial till monitoring points prior to sampling; only the Great Miami Aquifer monitoring wells are to be purged prior to sampling.

A dedicated Teflon bailer or pump shall then be used to purge the Great Miami Aquifer well of the required purge volume prior to sampling in accordance with the procedure; following removal of the required purge volume, the sample shall be collected using the dedicated Teflon bailer.

Great Miami Aquifer monitoring point samples shall be collected using a dedicated Teflon bailer. All sampling activities shall be completed in accordance with Standard Operating Procedure SC-GM-FO-201, "Groundwater Sampling Activities."

NOTE 5: Prior to collecting the sample, the volume contained in the LCS, LDS, and glacial till monitoring points are to be estimated to determine if sufficient volume is present for the full suite of analytical parameters (see Table B-1 and/or Table B-2 , or corresponding tables in future addenda).

If sufficient volume is present in a system for a *full suite* of analytical parameters *at standard volume*, then collect a full sample at standard volume from the system. Else, if sufficient volume is present in a system for a *full suite* of analytical parameters but *at minimum volume*, then collect a full suite of analytical parameters at minimum volume from the system. Else, collect a *partial sample at minimum volume with prioritized analytical groupings* (see Table B-1 and/or Table B-2, or corresponding tables in future addenda) as volume allows.

If volume sufficient for a full set of analytical parameter groups is present in one or more systems but not all the systems (*e.g.*, sufficient volume in LCS but not in LDS monitoring point), then collect a full sample at standard volume from the system(s) with sufficient standard volume (*e.g.*, LCS), and either a full set of analytical parameters at minimum volume, or a partial sample at minimum volumes with prioritized analytical groupings, as volume allows from the other(s), and make appropriate notation in the field log.

The field data from the above activities will be entered into the Sitewide Environmental Database (SED).

B.2 Health and Safety

The health and safety issues regarding all sampling specified under this plan will be addressed by project-specific safety permits.

Each individual field personnel assigned to this project shall conform to all applicable precautionary surveys performed by the personnel representing the utility engineer, industrial hygiene, and radiological control. Concurrence to applicable safety permits (indicated by the signature of each individual field personnel assigned to this project) is expected of each individual in the performance of their assigned duties in the field.

The supervisor shall ensure that each individual field personnel assigned to sampling activities for the OSDF monitoring programs governed by this plan reads and understands the applicable surveys and permits; any field personnel who does not sign the applicable permit(s) shall not participate in the execution of these sampling activities. A current copy of the permit(s) shall be in the field with the field personnel during sampling events.

B.3 QA/QC Field Samples

Every sampling event will have the following field quality assurance samples collected at a frequency of 1 per 20 samples collected, or 1 per sampling event if fewer than 20 samples are collected; unless indicated otherwise below, analysis shall be for the entire suite of analytical parameters indicated in either Table 7-1 or Table 7-2, dependent on the purpose of the sampling effort and system from which the sample is collected (or corresponding tables in subsequent addenda):

- rinsate (required only if dedicated sampling equipment is not used);
- field blank;
- trip blank (only for parameter group 3. Volatile Organics);
- field duplicate; and
- one matrix spike/matrix spike duplicate (MS/MSD).

The field duplicate and MS/MSD shall be taken from the system(s) which has (have) sufficient volume for the entire suite of analytes at standard volume (likely the LCS and/or Great Miami Aquifer monitoring points).

B.4 Calibration of Field Equipment

All equipment used during this investigation shall be operated and calibrated according to the manufacturer's specification and in accordance with Standard Operating Procedure (SOP) SC-GM-FO-201, "Groundwater Sampling Activities." Written logs of equipment calibration are maintained by the personnel responsible for performing the instrument calibrations.

B.5 Sample Chain-of-Custody Records and Field Data Documents

Sample custody procedures outlined in the *SCQ* shall be adhered to throughout the sample handling process from field collection to shipment of the samples to the laboratory. A Custody

Record/Request For Analysis (COC/RFA) shall be used to document collection data, chain-of-custody, and geotechnical parameters requested for each sample in accordance with EW-0018 "Chain Of Custody/Request For Analysis Record For Sample Control."

In addition to the custody records, a Water Sample Collection Log shall be completed which summarizes all samples collected. All field work shall be documented in detail on a daily basis using the Field Activity Log (FAL). All field documentation will be completed by the lead sampling technician.

B.6 Sample Packaging, Storage, and Shipping

Sample custody seals and labels, and the COC/RFA will be examined and verified by water/groundwater monitoring team leader and personnel of the sample management organization prior to acceptance and shipment of samples. The field screening results will be clearly displayed on the sample label and the COC/RFA. Sample packaging shall be performed in accordance with Section K.10 of the *SCQ*.

Final sample handling, screening, storage, and shipping activities will be completed by the water/groundwater monitoring organization. Samples will be shipped to the designated off-site lab for the analyses required.

B.7 Equipment Decontamination

Sampling equipment shall be decontaminated prior to transport to the sample field site, and after all sampling is completed, to limit the introduction of contaminants from equipment to sampled media, and to protect worker safety and health.

The decontamination of equipment shall be a Level II Decontamination, as referenced in Section K.11 of Vol. II of the *SCQ* and as described in Section 6.4.1 of the *SCQ* and Section 5.7.6 of SOP SC-GM-FO-201, "Groundwater Sampling Activities."

B.8 Disposition of Investigation-Derived Wastes

During completion of sampling activities, water/groundwater monitoring sampling technicians may generate contact wastes and decontamination waste. Following completion of sampling, the water/groundwater monitoring sampling technicians shall place contact wastes into properly labeled bags and disposition in accordance with appropriate FEMP waste management policies. Purge water will go to the Biodenitrification Surge Lagoon. The water/groundwater monitoring sampling technicians shall decant decontamination solution into appropriate containers which will be ultimately transferred to Plant 8 or the Advanced Wastewater Treatment (AWWT) facility for treatment.

TABLE B-1

OSDF GROUNDWATER/LEAK DETECTION MONITORING PROGRAM
SAMPLING & ANALYSIS REQUIREMENTS FOR THE LCS, LDS, GLACIAL TILL AND GREAT MIAMI AQUIFER

Parameter Groups/Parameters	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Minimum Volume	Standard Volume	Container[c]
1. Radionuclides:								
Technetium-99	SCQ[d]	2	C	6 Months	HNO_3 to pH < 2	500 ml	1L	Plastic or glass
Uranium, total	SCQ[d]	1	C	6 Months	HNO_3 to pH < 2	10ml	100ml	Plastic or glass
2. Inorganics (Metals):								
Boron	CLP[e]	7	C	6 Months	HNO_3 to pH < 2	300ml	1L	Plastic or glass
Mercury	CLP[e]	7	C	28 Days	HNO_3 to pH < 2		1L	Plastic or glass
3. Volatile Organics: Bromodichloromethane 1,1-Dichloroethene 1,2-Dichloroethene (total) Tetrachloroethene Trichloroethene Vinyl chloride	CLP[e]	3	C	7 Days or 14 Days	Cool to 4°C or Cool to 4°C H_2SO_4, HCl, or solid $NaHSO_4$ to pH < 2	1X40 ml	3X40ml	Glass vial with Teflon lined septum cap[f]
4. Semi-Volatile Organics: Carbazole bis(2-Chloroisopropyl)ether 4-Nitroaniline	CLP[e]	6	C	7 Days to extraction 40 Days from extraction to analysis	Cool to 4°C	1L	2L	Amber glass bottle with Teflon lined cap
5. Pesticides: alpha-Chlordane	CLP[e]	8	C	7 Days to extraction 40 Days from extraction to analysis	Cool to 4°C	1L	2L	Amber glass bottle with Teflon lined cap

Parameter Groups/Parameters	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Minimum Volume	Standard Volume	Container[c]
6. General Chemistry:								
Total Organic Halogens (TOX)	9020[i]	4	B	28 Days	Cool to 4°C H_2SO_4 to pH < 2	125 ml	250ml	Amber glass bottle with Teflon lined septum cap[f]
Total Organic Carbon (TOC)	9060[i]	5	B	28 Days	Cool to 4°C H_2SO_4 to pH < 2	20ml	40ml	Amber glass bottle with Teflon lined septum cap
pH	Field	1	A	NA[h]	NA[h]	NA[h]	NA[h]	NA[h]
Specific Conductance	Field	1	A	NA[h]	NA[h]	NA[h]	NA[h]	NA[h]

[a] If sufficient volume is not available for collection of the full suite (groups 1-6) at standard volume, then the minimum volume is to be collected for all analytical groups (Primary Parameter groups 1-5, and Supplemental Indicator Parameter group 6); if sufficient volume is still not available for collection of the full suite, then a partial sample is to be collected in accordance with the indicated priority.
[b] Analytical Support Level, as defined in the SCQ.
[c] Container size is left to the discretion of the individual laboratory.
[d] Radionuclide analyses do not have standard methods; however, the analytical specifications for these parameters are provided in Appendix G of the SCQ.
[e] EPA Contract Laboratory Program Statement of Work, Multi-Media, Multi-Concentration, most recent revision.
[f] No head space.
[g] Field parameters include dissolved oxygen, pH, specific conductance, temperature and turbidity.
[h] NA = Not applicable.
[i] Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.

Note: Detection limits and highest allowable minimum detectable concentrations will be below the FRLs.

TABLE B-2

OSDF LEACHATE MONITORING PROGRAM
SAMPLING AND ANALYSIS REQUIREMENTS FOR THE LEACHATE MANAGEMENT PROGRAM

Parameter Groups/Parameters[a]	Method	Priority[b]	ASL[c]	Holding Time[d]	Preservation[d]	Minimum Volume	Standard Volume	Container[d,e]
1. General Chemistry:								
Nitrogen, Ammonia	350.1[f], 350.3[f], 4500C[g], or 4500E[g]	7	B	28 Days	Cool to 4°C, H_2SO_4 to pH < 2	100 ml	500 ml	Plastic or glass
Chemical Oxygen Demand	5220D[g]	9	B	28 Days	Cool to 4°C, H_2SO_4 to pH < 2	20 ml	100 ml	Plastic or glass
Chloride	325.2[f] or 4500B[g]	5	B	28 Days	None	50 ml	250 ml	Plastic or glass
Nitrogen, Nitrate/Nitrite	353.1[f], 353.2[f], 4500D[g], or 4500E[g]	1	B	28 Days	Cool to 4°C, H_2SO_4 to pH < 2	20 ml	100 ml	Plastic or glass
Sulfate	375.2[f] or 4500E[g]	6	B	28 Days	Cool to 4°C	50 ml	120 ml	Plastic or glass
Total Alkalinity	310.1[f] or 2320B[g]	8	B	14 Days	Cool to 4°C	20 ml	100 ml	Plastic or glass
Total Dissolved Solids	160.1[f] or 2540C[g]	2	B	7 Days	Cool to 4°C	100 ml	250 ml	Plastic or glass
Total Organic Carbon	9060[h]	1	B	28 Days	Cool to 4°C, H_2SO_4 to pH < 2	20 ml	40 ml	Amber glass bottle with Teflon lined cap
2. Inorganics (Metals): Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc	CLP[i]	4	C	6 Months	HNO_3 to pH < 2	600 ml	1 L	Plastic or glass
3. Volatile Organics: [Also on Table B-1] Bromodichloromethane, 1,1-Dichloroethene, 1,2-Dichloroethene (total), Tetrachloroethene, Vinyl chloride	CLP[i]	3	C	7 Days or 14 Days	Cool to 4°C or Cool to 4°C H_2SO_4, HCl, or $NaHSO_4$ to pH < 2	1 x 40 ml	4 x 40 ml	Glass vial with Teflon lined septum cap[j]

TABLE B-2 (Continued)

Parameter Groups/Parameters[a]	Method	Priority[b]	ASL[c]	Holding Time[d]	Preservation[d]	Minimum Volume	Standard Volume	Container[d,e]
4. **Volatile Organics:** **[Not on Table B-1]**[k]	CLP[i]	3	C	7 Days or 14 Days	Cool to 4°C or Cool to 4°C H_2SO_4, HCl, or $NaHSO_4$ to pH < 2	1 x 40 ml	4 x 40 ml	Glass vial with Teflon lined septum cap
5. **Field Parameters**[l]**:** pH, Specific Conductance, Temperature, Turbidity		1	A	NA[m]	NA[m]	NA[m]	NA[m]	NA[m]

[a] All parameters in Table B-2 that are also in Table B-1 along with Nitrogen, Nitrate/Nitrite and Total Dissolved Solids will be monitored quarterly. All other parameters in Table B-2 will be monitored annually.
[b] If sufficient volume is not available for collection of the full suite (Groups 1-5) at standard volume, then the minimum volume is to be collected for all analytical groups; if sufficient volume is still not available for the collection of the full suite, then a partial sample is to be collected in accordance with the indicated priority.
[c] Analytical Support Level, as defined in the SCQ.
[d] Appropriate preservative, holding time, and container requirements will be used for the corresponding method.
[e] Container size is left to the discretion of the individual laboratory.
[f] "Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020.
[g] "Standard Methods for the Analysis of Water and Wastewater," 17th edition.
[h] Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.
[i] EPA Contract Laboratory Statement of Work, Multi-Media, Multi-Concentration, most recent revision.
[j] No head space.
[k] 1,1,1-Trichloroethane; 1,1,1,2-Tetrachloroethane; 1,1,2,2-Tetrachloroethane; 1,1,2-Trichloroethane; 1,1-Dichloroethane; 1,2-Dibromo-3-chloropropane; 1,2-Dichloroethane; 1,2-Dichloropropane; 1,2,3-Trichloropropane; 2-Butanone; 2-Hexanone; 4-Methyl-2-Pentanone; 4-Methyl-2-pentanone; Acetone; Acrylonitrile; Benzene; Bromochloromethane; Bromoform; Bromomethane; Carbon Disulfide; Carbon Tetrachloride; Chlorobenzene; Chloroethane; Chloroform; Chloromethane; Dibromochloromethane; Ethylbenzene; Ethylene dibromide; Methylene bromide; Methylene chloride; Methyl iodide; Styrene; Toluene; Trichloroethene; Trichlorofluoromethane; Vinyl Acetate; Xylenes, Total; cis-1,3-Dichloropropene; trans-1,2-Dichloroethene; trans-1,3-Dichloropropene; trans-1,4-Dichloro-2-butene; 1,2-Dichlorobenzene, 1,4-Dichlorobenzene.
[l] Field parameters include dissolved oxygen, pH, specific conductance, temperature, and turbidity.
[m] NA = Not applicable.

Note: Detection limits will be below the FRLs.

APPENDIX C

QUALITY ASSURANCE/QUALITY CONTROL

C.0 QUALITY ASSURANCE/QUALITY CONTROL

C.1 Introduction

The primary objectives of the Quality Assurance/Quality Control (QA/QC) section of this plan relate to the collection of field information and data sufficient to evaluate the OSDF leak detection and leachate monitoring programs. Specific objectives of this field sampling effort shall be designed, organized, and implemented in a manner which will optimize the collection of information which meets the data quality objectives (DQOs). To ensure information is gathered in such a manner that DQOs are met, QA/QC measures will be used to determine conformance with overall project and program objectives.

The fundamental mechanisms used to achieve these quality goals can be characterized as prevention, assessment, and correction. These components are further described as follows:

- Prevention of defects in the data quality through planning and design, documented instruction and procedures, and careful selection and training of skilled, qualified personnel.

- Quality assessment through program or regular audits and surveillance to supplement continual informal review.

- Permanent correction of conditions adverse to quality objectives through a closed-loop corrective action system.

C.2 Quality Assurance/Quality Control Requirements

All FEMP sampling programs follow protocol established in the *Sitewide CERCLA Quality Assurance Project Plan (SCQ)*, in Vol. I, Section 4, and in Vol. II, Appendix K.

Self-assessment and independent assessments of work processes and operations shall be undertaken to assure quality of performance. Self-assessment shall be performed by the Quality Assurance Officer assigned to the OSDF Groundwater Monitoring Program. Self-assessment activities shall encompass technical and procedure requirements, and may be conducted at any point in the project.

At a minimum, one surveillance shall be conducted per sampling event, consisting of monitoring/observing on-going project activity and work areas to verify conformance to specified requirements. Surveillance shall be planned and documented in accordance with Section 12.3 of the *SCQ*.

Requirements for QA/QC samples are presented in Appendix B.3.

C.3 Field Changes

Prior to the implementation of field changes, the OSDF Groundwater Project Manager and Groundwater Monitoring Manager shall be informed of the proposed field changes. Once the OSDF Groundwater Project Manager has obtained approval (verbal or written) from the OSDF Project Manager and Quality Assurance (QA) representative for the field changes to the plan, the field changes may be implemented. Field changes to the plan shall be noted on a Variance Request form. The QA representative must receive the completed Variance Request form, which includes the signatures of the OSDF Groundwater Manager, OSDF Project Manager, and the QA representative, within one week of the granting of the verbal approval.

APPENDIX D

DATA MANAGEMENT PLAN

D.0 DATA MANAGEMENT PLAN

D.1 Introduction

This data management plan will be implemented so that information collected during the investigation will be properly managed following completion of the field activities. Data and field documentation generated during the investigation shall be validated to ensure compliance with the DQOs of this program.

D.2 Field Documentation Validation

As specified in Section 5.1 of the *SCQ*, sampling teams shall describe daily activities on the FAL sufficient for the sampling team to reconstruct a particular situation without reliance on memory. Sample collection logs shall be completed according to instructions specified in Appendix B of the *SCQ*.

To assure appropriate documentation was completed during field activities and that documentation was completed correctly, field documentation shall be validated by the environmental monitoring group and Quality Assurance (QA) as described in Section D.5 of Vol. II of the *SCQ*.

D.3 Analytical Data Validation

Analytical data shall be validated by the data quality group upon receipt. Analytical Support Level (ASL) for deliverables shall be requested from the laboratory for all parameters in accordance with Table B-1 (or corresponding tables in future addenda to this plan). Validation shall be performed to the highest ASL permitted by the data.

The data quality group shall provide to the Project Manager and to the analytical data management (ADM) group copies of the summary reports listing validation qualifiers applied along with copies of the validated data sheets. All original validation summary forms and validation reports shall be submitted to the ADM group for permanent storage.

D.4 Data Entry

Analytical data shall be received from the contract laboratory by electronic data transfer in a compatible format with the FEMP database and in hard-copy format. Validated field data shall be entered into the FEMP Site-Wide Environmental Database (SED) by the ADM group in a timely manner. Manual, double keyed data entry shall be completed and the entered data shall be compared to the original data sheets; corrections shall be initialed and dated, and made as necessary. Hard-copy documents are kept in permanent storage in the project. Data from the SED will be provided to OEPA in a compatible electronic format.